ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 66. No. 23. 505 Pearl St., New York, December 7, 1911.

TABLE OF CONTENTS.

LEADING ARTICLES: Page

How the United States Spent a Million Dollars in an Ineffectual Attempt to Control the Lower Colorado River (illustrated); H. T. Cory, M. Am. Soc. C. E. ... 667

A Reply to Mr. Cory's Article on Work on the Colorado River Break in 1911 (illustrated); J. A. Ockerson, M. Am. Soc. C. E. ... 671

General Features of Bull Run Conduit No. 2, Water-Supply of Portland, Ore.; D. D. Clarke, M. Am. Soc. C. E. ... 673

What Gage Should Be Made Standard on Australian Railways? James Alex. Smith ... 674

Operating Statistics of the Municipal Electric Plant of Pasadena, Cal. ... 675

An Electric Motor-Truck Crane (illustrated) ... 675

A Difficult Piece of Diamond Drilling (illustrated) ... 676

"The Battle of the Flies"; A Ballad of the Line; Alleyne Wright. 676

A New Machine Tool for Boring Square Holes (illustrated) ... 677

Deflocculation; Edward G. Acheson, M. Am. Soc. Chem. Eng. ... 677

The Engineer's Work in Grading Landscape Areas (illustrated); John N. Ambler, M. Am. Soc. C. E. ... 678

Electric-Crane Cars for the Public Service Railway, Newark, N. J. (illustrated) ... 679

Tests of Large Boilers at Detroit (illustrated); D. S. Jacobus, M. Am. Soc. M. E. ... 680

A Recording Voltmeter, Ammeter and Pyrometer of Accuracy and Great Sensitiveness (illustrated) ... 682

A Structural and Corrugated Steel Stack (illustrated); Percy Elmer Barbour ... 683

Flood Prevention Works in the Province of Silesia in Germany; The Maurer Dam ... 683

Caryl Davis Haskins (illustrated) ... 684

Notes From a Railway Engineer's Experience in West Africa; Assoc. M. Can. Soc. C. E. ... 684

A Multi-Ported Back-Pressure Valve (illustrated) ... 690

Suggestions for a Model Street Railway Franchise; James W. S. Peters and Delos F. Wilcox ... 690

Work of the International Electrical Congress and the International Electrotechnical Commission at Turin, Italy ... 691

The Interstate Commerce Commission's Report on the Lehigh Valley R. R. Wreck Near Manchester, N. Y., on Aug. 25, 1911 ... 692

The Manufacture of Agricultural Implements in the United States During 1904 and 1905 ... 692

EDITORIAL ... 685

Removal of Engineering News Publication Office—The Confession of Guilt by the McNamara Brothers—Would a Broader Gage Than the Present Be Advantageous for American Railways?—Another French Quest for the Last Germ in City Water-Supplies—Should Engineers or Politicians Be Put in Control of Highway Construction?—The Free Bridge Engineering Offer by the Office of Public Roads.

The Control of the Lower Colorado River; What Methods Should Be Adopted? ... 686

LETTERS TO THE EDITOR ... 678

The Offer of Free Highway Bridge Engineering by the Office of Public Roads; L. W. Page, M. Am. Soc. C. E.; John C. Trautwine, Jr.; John V. Hazen

ENGINEERING NEWS OF THE WEEK ... 693

PERSONALS ... 694

ENGINEERING SOCIETIES ... 694

How the United States Spent a Million Dollars in an Ineffectual Attempt to Control the Lower Colorado River.*

By H. T. CORY,† M. Am. Soc. C. E.

During the last days of the 61st Congress a resolution was passed, and on June 25, 1910, approved, placing $1,000,000 at the disposal of President Taft to be used for the protection of the Imperial Valley, in Southern California, against threatened disaster from the Colorado River. Such action was taken because of urgent representation from California that an emergency existed, the immediate cause being the diversion of the Colorado River from its old channel westward into Volcano Lake, some fifteen miles below the point where the river had diverted in 1905-7 into the Salton Sea.

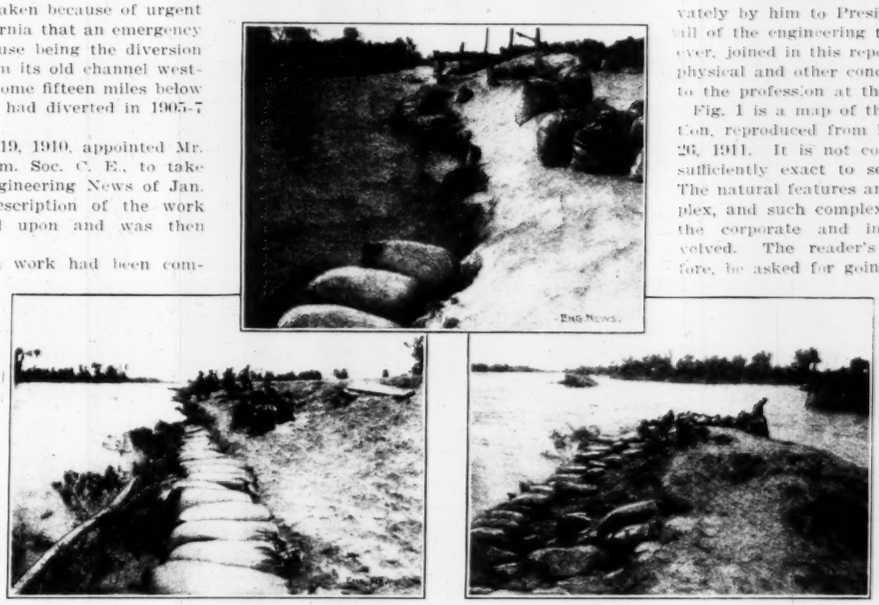
President Taft on July 19, 1910, appointed Mr. John A. Ockerson, M. Am. Soc. C. E., to take charge of the work. Engineering News of Jan. 26, 1911, contained a description of the work which had been decided upon and was then under way.

In May, 1911, all such work had been completed at a cost of approximately $900,000, and for all practical purposes had been utterly destroyed or rendered useless.

In May the situation was reported through proper channels to President Taft, who appointed a Board of Review consisting of Gen. W. L. Marshall, Consulting Engineer U. S. Reclamation Service; F. H. Newell, Director U. S. Reclamation Service; C. E. Grunsky, formerly Consulting Engineer U. S. Reclamation Service; J. B. Lippincott, formerly of the U. S. Reclamation Service but now an assistant engineer on the Los Angeles Aqueduct; and Mr. J. A. Ockerson. To these was added Gen. Harrison Gray Otis, proprietor of the Los Angeles "Times."

This Board met in Washington, and on June 7, 1911, sent in its findings to the Secretary of the Interior. This report, it was given out at the time, was a unanimous one, and stated that the work which had been done conformed in all respects to the best engineering practice and praised the aggressiveness with which it had been carried out, the exact wording being as follows:

> The members of the conference desire to call attention to the fact that the plan and execution of the work accomplished during 1911 followed well-established principles of good engineering. That so large an amount was accomplished in such a brief space of time, under adverse circumstances, is worthy of the highest commendation.



PROTECTIVE WORK ON COLORADO RIVER LEVEE.

A.—Trying to prevent destruction from behind, necessitated, in part, by location in trough. B.—Protection from erosion. Trees on left mark far side of levee borrow pits. C.—Trying to hold end of broken levee.

Inasmuch as $50,000 would be a liberal estimate of the reproduction value of what was left of the work in question at the time the Board made this report, and which could be incorporated in future constructions, one might infer from the report that protective work of this kind is futile and the situation desperate.

The Editor of Engineering News, therefore, requested the writer to prepare for this journal an article, explaining the peculiar conditions, which render the situation along the lower Colorado so desperate, and to explain if possible the apparent contradiction of the quoted excerpt of the Reviewing Board, with its recommendations to at once proceed along somewhat different though practically the same lines for the protection of the interests in jeopardy.

In passing, it should be stated that the report of the Board was not a unanimous one, as was understood, but that Gen. Harrison Gray Otis—the only member who is not an engineer—declined to sign it and prepared a minority report which, at the urgent request of the other members, was not submitted, but was presented privately by him to President Taft. The fact that all of the engineering talent on the Board, however, joined in this report makes a review of the physical and other conditions of peculiar interest to the profession at this time.

Fig. 1 is a map of the region under consideration, reproduced from Engineering News of Jan. 26, 1911. It is not correct in its detail, but is sufficiently exact to serve the present purpose. The natural features are more than usually complex, and such complexity is much increased by the corporate and international interests involved. The reader's indulgence must, therefore, be asked for going into considerable detail, for otherwise serious misconceptions of the true situation would be inevitable.

Properly speaking, the Imperial Valley is all that portion of country lying on the land side of what is shown on the map as the "California Development Co. levee" and north of Volcano Lake to the mountains on the west; the mountains and sandhills on the north and east; and extending 20 miles north and northwest of Imperial to Salton Sea. This area is remarkably unbroken except for the deep, wide gashes cut back as far as Pasqualito and Sharp's Heading, respectively, by the Colorado River in 1905 and 1906, when it was entirely diverted into and formed the Salton Sea) and which are known as the New and the Alamo rivers. The slope of this region is about 5 ft. per mile and is practically uniform toward the northwest. This immense body of marvelously fertile land is irrigable from the Colorado River. Approximately 300,000 acres in the United States and 30,000 acres in Mexico are now under canals, much of it having been reclaimed for almost ten years.

The irregular dotted area westerly from Pilot

*This article was prepared by its author after a personal visit to and inspection of the work which it describes made at the request of the Editor of Engineering News for the purpose of ascertaining the facts and preparing the articles. For articles on the early history of the struggle with the Colorado River see Eng. News, Feb. 22, 1906, p. 216; March 15, 1906, p. 300; May 10, 1906, p. 512; and Dec. 27, 1906, p. 671, the last by Mr. Cory.

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Knob is covered with shifting masses of fine, white sand and is locally known as the "sand hills," which precludes the Southern Pacific's main line being maintained south of its present location west of Ogilby on the one hand and on the other the construction and maintenance of any waterway (other than a tunnel of impracticable length and cost) lying wholly in the United States, to carry the waters of the Colorado River to that portion of the Imperial Valley lying in the United States.

Irrigation water for this region must therefore be conveyed thereto for about 40 miles through Mexico, which fact is responsible for much complexity of various kinds, and thus in a sense for considerable bad engineering practice, with occasional resulting disaster.

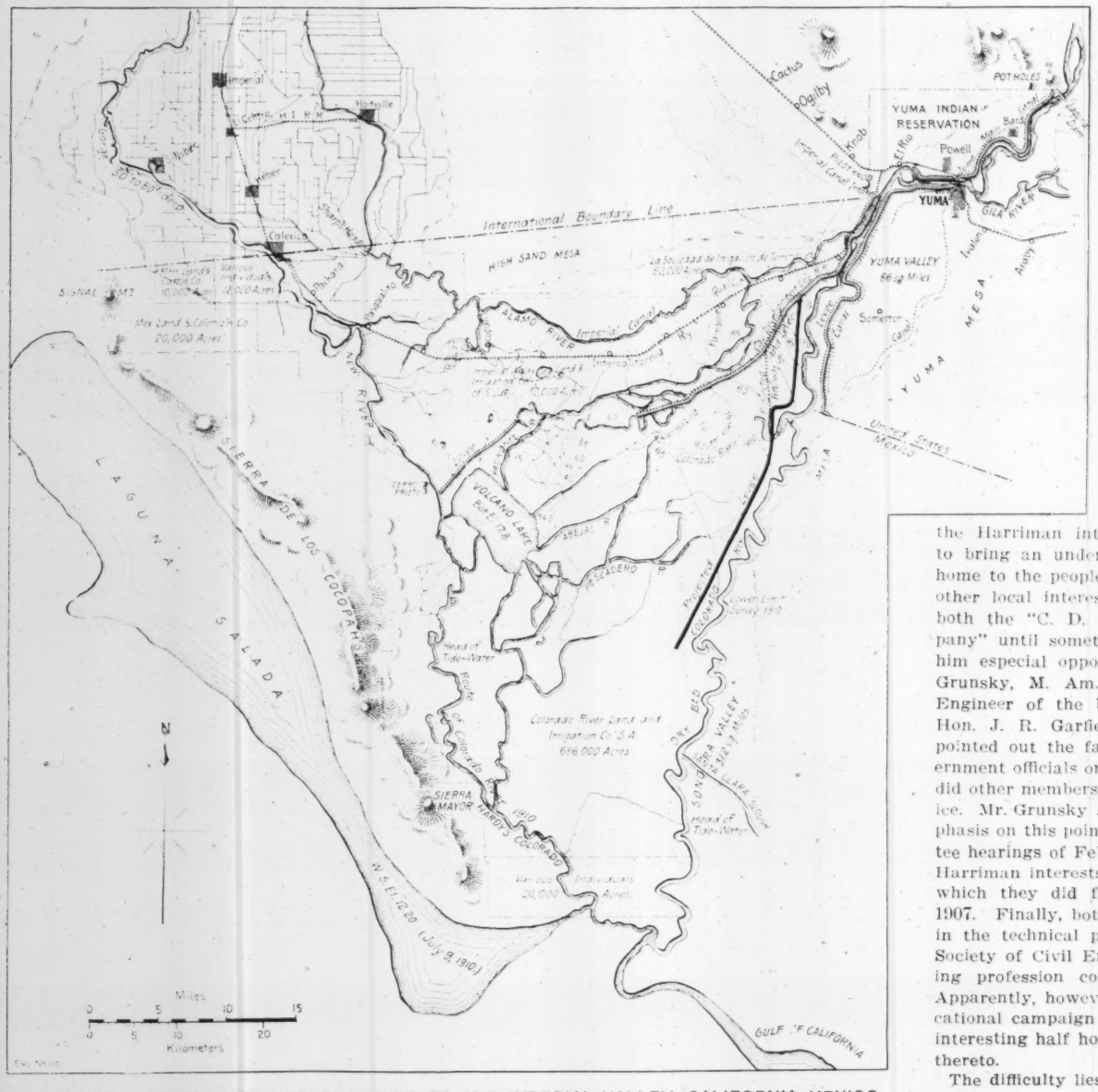

FIG. 1. MAP OF THE LOWER COLORADO DELTA AND IMPERIAL VALLEY, CALIFORNIA-MEXICO.

(Reproduced from Engineering News, Jan. 26, 1911.)

The method adopted for the irrigation of the Imperial Valley was the formation of the California Development Company—usually called the "C. D. Co.," a New Jersey corporation—and a subsidiary Mexican corporation, the Sociedad de Riego y Terrenos de la Baja California, S. A., commonly known as the "Mexican Company." Water is diverted from the Colorado River (under a water appropriation made in California) by the "C. D. Co." about a thousand yards above the International Boundary Line; turned over at the Boundary Line to the "Mexican Company," which conveys it through its canal system to irrigated lands in Mexico, as required, and sends the remainder—over 90% at present—back to several points on the Boundary Line in Imperial Valley; and finally at these points the water is—practically speaking—turned back to the "C. D. Co." and by it divided out to a number of mutual water companies composed of the actual land owners.

The essential point is that any and all work done by the irrigation companies on Mexican soil must be done by the "Mexican Company" and by the "Mexican Company" only. For example, Mr. Epes Randolph, President of the Harriman roads in Mexico, and the writer handled the work of closing the crevasses in the west bank of the Colorado River (at the bend in the "C. D." levee four miles south of the International Boundary Line) in 1906 and 1907, the former as President and the latter as General Manager and Chief Engineer of the "Mexican Company." In closing the first crevasse, as described in Engineering News of Dec. 29, 1906, the money came to the "Mexican Company" from the "C. D. Co.," which in turn borrowed it from the Southern Pacific Co.

In closing the second break at the urgent request of President Roosevelt—the operations from Dec. 8, 1906, to July 21, 1907—the money was furnished the "Mexican Company" by Epes Randolph as Agent of the Southern Pacific Co., and the "C. D. Co." had nothing to do with the matter whatever. Everyone on the work assumed as a matter of course that the Harriman interests were doing this work for the United States Government, in the capacity of a contractor, as an emergency measure and for actual cost.

The Government has not yet paid its bill for this work; but that in no wise alters the fact that practically the Government did the work in Mexico to protect the American Imperial Valley and did so through the machinery of the "Mexican Company."

There is another corporation through which work can be done on the Mexican side of the line—a land company known locally as the "C. M. Co.," and having the official name of the Colorado River Land Co. Its president is General Harrison Gray Otis, owner of the Los Angeles "Times," and the civilian member of the reviewing Board, and all the other stockholders are Southern California people. The "C. M. Co." owns about a million acres in the region, most of which is in the Colorado delta; indeed, all of the delta which lies in Mexico and has any value, except a total of about 130,000 acres, all of which latter lies on the land side of the "C. D." levee.

Every foot of the levees and all other works of every description done by the Harriman interests at President Roosevelt's request in 1906-7, is in perfect condition today and has never shown a sign of weakness. It must be frankly stated, however, that only such work was done at that time as seemed essential until suitable provisions could be made to properly care for the situation in a comprehensive manner.

It was pointed out very clearly to the various interests affected that no time was to be lost in completing the system of protection works which had been carried thus far by money supplied by the Harriman interests. The writer undertook to bring an understanding of the real situation home to the people of Imperial Valley and to the other local interests—being General Manager of both the "C. D. Co." and the "Mexican Company" until something over a year ago afforded him especial opportunity to do this. Mr. C. E. Grunsky, M. Am. Soc. C. E., then Consulting Engineer of the U. S. Reclamation Service for Hon. J. R. Garfield, Secretary of the Interior, pointed out the facts to the United States Government officials on more than one occasion, as also did other members of the U. S. Reclamation Service. Mr. Grunsky and the writer spoke with emphasis on this point at the Congressional Committee hearings of February and March, 1908, on the Harriman interests expense account for the work which they did from December, 1906, to July, 1907. Finally, both Mr. Grunsky and the writer, in the technical press and before the American Society of Civil Engineers, advised the engineering profession concerning the exact situation. Apparently, however, the only result of that educational campaign was to furnish a more or less interesting half hour to the parties who gave ear thereto.

The difficulty lies in the fact that three-fourths of the property interests needing protection belong to individuals and to the small local companies in the American Imperial Valley, and there is no possible way of legally combining them to collect and expend money on Mexican soil for such protection. In addition the feeling is quite general there and elsewhere that citizens in America should not be put to any expense to protect their property from a menace originating on foreign soil.

The summer flood of 1907 was unusually great in both the total discharge for the flood season and in the maximum or peak discharge reached. The delta lands below the "C. D." levee line—which region is often called the Volcano Lake Basin for want of a better name—had not had their usual yearly over-bank inundation for practically two seasons because of the Colorado's diversion into the Salton Sea. Hence the vegetation had largely died out and much of the area had been burned over. The river channel below

the diversion point was also silted up and had a minimum carrying efficiency. The result was an unprecedented inundation of the lower Colorado delta. The slope of the land close by the river toward Volcano Lake Basin being much greater than the river channel itself, the erosion of numerous fingers started back toward the river. When the flood season had passed it was very evident that unless something was promptly done the river would again be diverted to the west, this time, however, into the Volcano Lake Basin and thence to the Gulf of California, instead of into the Salton Sea, which has no outlet.

This was distinctly disquieting to all parties concerned. The lands of the "C. M. Co." had suffered severe damage and were plainly in for more. The danger of filling the Volcano Lake Basin so full as to make it overflow northward into the Salton Sea—after which but a few months of flood would be required to have the Colorado again diverted into the Salton Sea—was more than disquieting to the Imperial Valley, the Southern Pacific Co., and the U. S. Reclamation Service (because of its Laguna Dam 14 miles above Yuma). Furthermore, the Mexican Government's representative, Senor Ferdinando Beltran y Puga, with whom the writer discussed the situation fully, was deeply impressed with the menace. Nevertheless, to use a poker term—which by the way is singularly apt in this case—everybody stood pat and did nothing.

The Southern Pacific yielded first, and in spite of the fact that Congress had not paid the bill of the Harriman lines for work already done, furnished the "Mexican Company" money to partially build another section of the levee system—that shown on the map from the mountains west of Volcano Lake easterly about six miles. The Mexican Government was the only other interest which did a single thing. Under Senor Beltran y Puga, two complete surveying parties spent two months acquiring engineering data!

The summer flood of 1909 showed that the western diversion of the river would occur at the Abejas cut and was certain to become an accomplished fact with another flood. This time the Southern Pacific declined to take action. The writer, in local charge of the situation for the Harriman interests, was convinced that standing longer in the breach was no more to the final and real interests of the other parties than to those he represented, and this view was entirely concurred in by his superior officials. Finally, as the annual summer flood of 1910 neared its crest a frantic and unanimous appeal was sent to President Taft; and Congress, on June 29, 1910, a few days before adjournment, passed a bill placing $1,000,000 in President Taft's hands to "save Imperial Valley." At the same time the Harriman interests furnished the money, and through the "Mexican Company" partially built a considerable part of the remaining gap in the "C. D. Co." levee, as originally designed by the writer. By so doing the back waters of the Volcano Lake Basin, which in the summer flood of 1910 reached unprecedented heights, were kept from getting north into Salton Sea.

As already stated, on July 19, 1910, President Taft appointed Mr. J. A. Ockerson, M. Am. Soc. C. E., to take charge of the situation, and gave him unusual powers. This selection was considered fortunate not only because of the experience Mr. Ockerson had had on the Mississippi River but also because he had actually been on the Colorado River on at least two occasions, which it was hoped would help some.

All of the endangered interests proffered assistance of every possible kind, but as a rule such offers were declined with thanks, and the explanation that it was deemed best to obtain all information at first hand and free from bias. It was furthermore decided to expend the money of the United States Government through the channels of the "C. M. Co."—which as explained is a Mexican land company—rather than through the so-called "Mexican Company," controlled by the Southern Pacific Co. The reason for such selection probably was that as the "C. M. Co." never had done anything in the matter but stand pat, it had no engineering data to mislead and no expenses therefore incurred by it to recoup in some covert manner.

The proof of the pudding is the eating thereof; and since the Colorado River is flowing exactly where it would have been had not a cent of the $1,000,000 appropriation been expended, and still there are no immediate evil results, let alone disaster, it is clear there was no necessity for precipitate action. The writer happens to know that the engineers who knew most about the situation were a unit in believing this to be the case, including Mr. Ockerson, as shown in his report to the Secretary of Interior, dated Oct. 4, 1910.

For some reason, however, and without waiting to acquire enough instrumental engineering data appreciably to augment the very meager, desultory and disconnected data which had been acquired by the engineers of the U. S. Reclamation Service, the Mexican Government, the "Mexican Company" and the Inter-California Railway (a Southern Pacific subsidiary company), a map was prepared and the work to be done at once laid down thereon. The final drawing is practically that shown in Fig. 1 and is, with very few additions, the same as that prepared by the "Mexican Company" under the writer's direction as an adjusted compilation of all obtainable information of the region at that date, a copy of which was furnished Mr. Ockerson.

The two lines of levee system indicated upon the map show the two obvious possibilities of keeping the Colorado River from again diverting itself into the Salton Sea basin, the one marked "California Development Co. Levee," following a

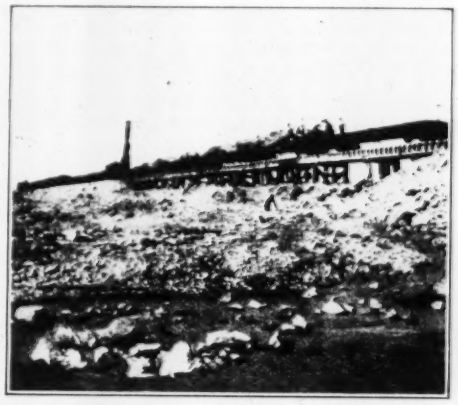

Fig. 2. Closing the Abejas Break.
(Water over rock fill had materially lowered, because of breaks in levee.)

Fig. 5. One and One-Half Miles South of Abejas Break.

Fig. 3. Looking Toward Abejas Break.

Fig. 6. Two Miles South of Abejas Break.
(Dynamite being placed in a traverse which has caused erosion over half through levee. Water behind levee due to break higher up.)

Fig. 4. One Mile South of Abejas Break.
(Traverses have been removed by dynamiting. Trees to left mark far side of borrow pit.)

Fig. 7. Dynamiting Traverse on South Levee Two Miles Below Abejas Break.

FIGS. 2 TO 7. VIEWS OF COLORADO RIVER LEVEE WORK AT AND NEAR ABEJAS BREAK; TAKEN APRIL 28, 1911.

slightly elevated ridge which forms a natural divide between the Salton Sea basin on the north and the Volcano Lake Basin on the south; and the other possibility is indicated by the heavy black line marked "Projected Levee," closely paralleling the river to a point with an elevation sufficiently low to preclude the possibility of Colorado River water overtopping the natural divide just mentioned.

The former line of levees, if maintained at all times intact, would protect every interest in the United States and all that portion of the region in Mexico which lies to the north of it, and it would leave all the lands to the south subject to overflow during the annual summer flood and severe flashy winter floods, as at present. The line of levees along the river would, in addition, reclaim from overflow all that region lying between the two possible systems of defense, and since it is susceptible of irrigation from the Alamo River or Imperial Canal, would, in effect, render it irrigable land instead of grazing land.

This tract, as shown on the map, belongs to the "C. M. Co.," which, as explained, was the Mexican corporation through the channels of which the last work on behalf of the United States Government was done in Mexican territory.

In considering the situation it should be borne in mind that practically all of the ground lying between the two disconnected ends of the "C. D. Co.'s" levee is so high as to require little diking. Thus this line of levees is probably considerably the cheapest and most satisfactory in point of construction and maintenance, which are the important but not the only factors to be taken into consideration. On the other hand, Mr. Francis L. Sellew, M. Am. Soc. C. E., who for the past four years has been the engineer in charge of the Yuma Project, U. S. Reclamation Service, and who has in the writer's opinion more information regarding, and a keener insight into, the lower Colorado River situation than any engineer who is now or ever has been connected with either the United States or the Mexican Government, regards the line of levees close by the river as the best solution of the problem.

It is thus seen that there is certainly a great question which of the two plans should be followed, but it is also even more obvious that the question cannot be decided intelligently without many times more data gathered by surveys than have yet been obtained.

Consequently building the river system of protection before thorough investigation and surveys seems exceedingly unfortunate and ill advised. The writer has never felt he could justify his own course in deciding upon and constructing the "C. D. Co.'s" levees where they are except for the absolute necessity to do something which would prevent the then imminent disaster and which it was possible to do in the limited time. In the light of all information as yet available, however, such plan still seems to be best, and the Board of Review heretofore mentioned recommended its immediate completion as affording ample protection to all interests in the United States. Mr. Ockerson's disastrous experience with the river levee line evidently caused him to change his mind, since he joined the rest of the Board in their report of June 7, 1911, making such recommendation.

In justification of such haste, it must be remembered that the people of Imperial Valley, having finally found a way of getting results and being thoroughly aroused to the imperative need for something being done to protect them from disaster, were clamoring for action and making comparisons between the speed with which the Southern Pacific Co. operated during the season of 1906-7 and the deliberate procedure of Government work in general. The effect of so insistent a public opinion upon any one in charge of work is necessarily very great and the pressure is almost irresistible to compel action before a man is thoroughly satisfied that what is being done is the very best thing possible.

Having decided that the entire future control of the lower Colorado should be by means of a levee line close by the river, the next step, obviously, was the exact location of the levees and the point at which diversion work on the Abejas break or crevasse should be constructed. The only real danger to properly designed and maintained levees along the river is that it will cut through its own bank until it reaches and cuts away the earth upon which the levee itself is built.

However, in the original design and construction effective provision must be made to protect the river side of the levee from being washed away by the running water, partly because of the friable character of the soil and partly because of the heavy grade. The average grade of the river was over a foot to the mile, while on account of not following the river's twisting the grade line of the levee top frequently has a fall of 3 ft. to the mile.

To prevent any misunderstanding of the statements in the two preceding paragraphs it is essential to remember that here *maintenance* of levees other than against breaching is of vital importance. Indeed it would be as sensible to put a lamb out among a bunch of coyotes and expect it to thrive as to build a levee in this region and go away expecting it to remain intact. Such maintenance is not difficult nor does it involve especial risk, but it is almost as expensive as it is imperative. If left alone, in a few months a levee will be covered with a dense growth of weeds and brush, the roots of which attract burrowing animals and consequent disaster, while they render an inspection practically impossible. These growths must be kept down at a very large expense or must be prevented.

To reduce this maintenance cost and to protect the water side of the levee from being eroded by currents the "C. D. Co." levees were blanketed on top and on both sides with a 15-in. layer of a cementing gravel, which is generally used throughout the region by the Southern Pacific Co. as a ballast for its roadbed. This gravel blanketing and the method of applying it was described in Engineering News of July 11, 1907, and cost a great deal of money. The work was done in a most efficient and workmanlike manner by Mr. T. J. Hind, who was the Superintendent in charge of all the levee work which the Harriman interests did along the river. To place this gravel, a railroad track was laid on the top of the levee and left there to facilitate inspection and repairs of any and all kinds which may be necessary. Even with such elaborate precautions these levees have been regularly patrolled and kept in first-class condition at no small annual cost.

In the light of such experience it is difficult to understand the building of about twenty-five miles of levee with no provision whatever for its maintenance. The examining Board reported:

> That the restoration of the Colorado River to its former channel was not realized is chargeable to the delay in the negotiations which prevented prompt inauguration of the work and its prosecution during the low-water season and also to the disturbed political situation and the strike which demoralized the labor conditions.

This statement is entirely erroneous. As a matter of fact, the levees were completed, and in a sense the Abejas break was closed. The reason and the only reason why the Colorado River is now flowing westerly through the Abejas break, instead of down its old channel from this point of diversion to the Gulf of California, is because the levees, when built, either could not be maintained or were not maintained long enough for the workmen to get off the job. This, too, in spite of the fact that by that time the annual spring flood had but just commenced.

In the report which Mr. Ockerson made to the Secretary of the Interior, Oct. 4, 1910, it is pointed out that levees built at a distance of 3,000 ft. from the river bank are reasonably safe from breaching by side cutting of the river, and the levees were so located. It is certainly obvious to anyone that the closer the levees are to the river bank the greater this danger of breaching becomes, and that 3,000 ft. is safer than 300 ft. There are, on the other hand, excellent reasons for locating levees much closer to the river banks and then protecting those banks.

The most important of these reasons is that the vegetation in the region is tropical in its luxuriance, so that when overbank flow occurs the waters are impeded so greatly that the heavier silt contents at once deposit, and so on, with the result that a cross section of the river bank at any point is theoretically an hyperbola, the slope away from the river decreasing with the distance from it. Obviously, the conditions of vegetation at no two points are alike, but roughly speaking the fall from the river bank is about 1½ ft. in the first 100 ft. and approximately 2½ ft. in the first 300 ft. In 3,000 ft. the total fall averages about 6 to 8 ft. Consequently a levee 3,000 ft. away from the river bank must be built from 3 to 5½ ft. higher than if placed 300 ft. distant. The increased water-carrying capacity due to the greater distance back to the levee is very much smaller than would ordinarily be supposed, because the luxuriant vegetation makes the additional cross section extremely inefficient. For this reason, levees 3,000 ft. distant can safely be built but slightly less in actual elevation than at 300 ft. and upon much lower ground. Judging from meager data it appears that the elevation of the top of the levee built this year was fixed from the high-water marks on the trees along the levee line and hence the height of the levee actually constructed seemed not unduly great. Indeed, it would be surprising if careful surveys would not show that so small a flow as 100,000 cu. ft. per sec. in the river would not have overtopped considerable portions of it had it not been otherwise destroyed, because the high-water mark with a free get-away and the high-water mark with the levees holding back the overbank flow, would obviously be very different, entirely aside from any effect of the levees upon the height of water in the main channel of the river at any given time.

Overbank flow in this region concentrates into little streams which criss-cross and often practically parallel the river bank for considerable distances. These overbank-flow streams build up their beds just as the main river itself does, so that economic location of a levee requires a careful study to find the highest ground. This is difficult, slow work, because the underbrush is too dense to permit examining the ground in any other way than clearing cross lines at frequent intervals and getting profiles of them. This was not done, and the levee alinement fixed with the distance from the river idea in view. Indeed, for considerable stretches the action of the water in destroying long sections of the levee shows that the latter actually followed the bottoms of these shallow swales for long stretches.

As constructed, the levees were of the ordinary type, having a width of 8 ft. and side slope of 3 to 1. The ground was cleared, all stumps and roots removed, and a muck ditch dug under the axis of the levee to such depth as was necessary to get below the lowest layers of cracked adobe soil lying above the permanent water table. The muck ditch was refilled with good material before the levee proper was started. In all these respects the work followed careful, well-established engineering practice.

The real, or rather the immediate, cause of the disaster was the borrow pits. The material for making the levees was all taken from borrow pits on the river side, a berm of 40 ft. being left from the toe of the levee to the nearest edge of the pits. The borrow pits were made 400 ft. in length, and separated by a "traverse" 50 ft. wide on which all vegetation was left. The berm, however, was cleared continuously. Such an arrangement of borrow pits perhaps follows the best engineering practice along the Mississippi River, but almost insures immediate disaster along the Colorado. Very soon after the levees had been completed the river rose, and in several places sent considerable water overbank until it came to these levees.

At the same time the work of closing the Abejas break had progressed far enough to raise the water sufficiently to turn a small portion down the old channel. The total result was that perhaps 2,400 cu. ft. per sec. ran down along the levees extending southerly from the break. Had the borrow pits been continuous the water would have flowed down the channel thus formed as in

canal. Because of the uncleared traverses, however, such water was by them diverted toward the toe of the levee and rapidly eroded the river side. In a few days such erosion extended entirely through the levee in several places.

By the middle of May there were several distinct places north of the Abejas where the levee had been cut entirely through and 13 distinct places south of this point to Mile Post 18. How many more breaks had occurred below that point the writer is not informed. In addition there were of course many more places where the erosion did not extend entirely through but had cut away from half to all but a small fraction of the levee section. These complete breaks are from a few hundred feet in length to one stretch where for two miles not a vestige of the levee remains. In two or three long stretches the water cut through the levee, ran along on the land side and cut through back to the river side, criss-crossing three or four times. Obviously, in such cases the levee was located in one of the natural hollows before mentioned. The photographs taken on April 28, 1911, fully show the nature of these failures. (See Figs. 2 to 7.)

The net result is the creation of an efficient and straight channel for water paralleling the old river bed for many miles and rendering entirely out of the question the rebuilding of the levee on its original alinement. If a new levee is constructed closer to the river this channel will be a menace in case of break, at least until such time as the vegetation and material blown in may have practically obliterated it. If a levee be constructed behind the channel the danger of diverting the river itself over to this channel and undesirably near the new levee construction would be very great. The disconnected fragments as they now stand will tend to concentrate overbank flow and be no small injury to the lands of the C. M. Co.

Consequently if the river levee line is not built obviously none of the remaining works whatever will be of any value, to say the least. If such a river levee is built it will be impossible to incorporate into it more than about 4½ miles of the latest construction—at the upper end—which did not cost $50,000 and could be rebuilt for less than that sum. In the statement of facts which accompanied the report of the Board of Review the value of the works still intact was given at $431,050, and without explanation is entirely misleading. Such figures must have been obtained by estimating the levee section yardage in the levee work which was not washed away, at its contract price; and the value of the rock-fill dam with which the Abejas break was closed—and now utterly worthless—at what it cost to put it there.

By reference to Figs. 6 and 7 the water is seen on the land side of the levee flowing back into the Abejas break, and Fig. 2 shows work in progress on closing the break itself by means of a rock-fill dam. Just what purpose could have been served by finishing the closure of the break when water was going around through breaks in the levee and back into the Abejas below the dam, with the inevitable result of rendering the closure itself utterly useless within a few days at most is difficult to understand unless it should be to effect a technical compliance of instructions to close the break! It appears that work on the rock-fill dam was not discontinued until breaks in the levee north of the Abejas a few days later cut the railway by which rock was brought down from Pilot Knob.

There are conflicting reports as to whether endeavors were made to maintain the levee and stop the breaks occurring therein. The group of views lettered A, B, C, and also Figs. 3, 4 and 5 show a considerable amount of brush and earth sack protection. On the other hand, it was reported that the superintendent in charge of the work was peremptorily instructed to quit trying to hold the levee and push along as rapidly as possible the work on the rock-fill dam, the reason assigned being that there was a "million for construction but not one cent for maintenance."

In the statement of facts accompanying the report of the Reviewing Board, mention is made of damage to unprotected levees which gives rise to the inference that the work had not been completed as planned. The last of the levee contractors' plants was taken off the job on April 7 and several weeks earlier the levee section was completed for disconnected stretches aggregating a considerable proportion of the twenty-five miles in length. If it was contemplated to do any brush abatis or any other work to protect the levees against such erosion as destroyed them, there certainly was at least time to have had it well started. As a matter of fact no such erosion-protective work was apparently contemplated—at least no one on the job had ever heard of its even being under serious consideration.

The maximum amount of water ever flowing down along the levees at any point is reported to have been about 4,000 cu. ft. per sec. and the maximum depth somewhat less than 4 ft. The disastrous results of such a small amount of water is due to the peculiar friability of the soil, which precludes the possibility of using borrow pits of the type adopted.

In building the "C. D. Co." levees, fear of just such results caused the adoption of the heroic alternative of making the borrow pits on the land side only and every possible precaution was taken not to disturb in any way the natural vegetation on the river side of the levee. An exception must be made of a few miles on the southerly end, where what is known locally as the "checkerboard" system was put in on the recommendation of an advisory board of engineers of the U. S. Reclamation Service. This system consists of borrow pits 100 ft. in length along the river side of the levee, only, with 40-ft. berms, each pit being separated from the next one by a stretch 100 ft. in length where the vegetation is religiously left intact to the levee's toe. This type is used exclusively in the levee construction on the Yuma Project, U. S. Reclamation Service, under Project Engineer F. L. Sellew. It is not in the province of this paper to discuss the relative merits of the "checkerboard" and the land-side system of borrow pits in levee construction along the Colorado River. All that need be said here is that the destruction of the levees which were built last winter with practically continuous borrow pits on the river side conclusively shows, what experience in the region had already convinced local engineers some time since, the paramount importance of protecting levees against erosion by unbroken currents which are at all swift and eddying.

Fortunately, the Hardy and other channels have increased their carrying efficiency somewhat and now carry the waters from Volcano Lake basin so rapidly that Volcano Lake has not risen during this season's flood nearly so high as was feared, or enough to be at all menacing. The conditions resulting from a record summer flood, however, might be quite grave, and no time should be lost in providing for protective works along comprehensive and well-considered lines. Congress recently adjourned without making any further provision in the matter, but it appears there remains something over $100,000 of the original $1,000,000 appropriation. With such a sum expended on surveys probably enough instrumental data for all immediate practical purposes could be secured. Treaty arrangements with the Mexican Government can also be arranged. In this way something definite could be put before the next Congress for consideration.

In any event there is no time to waste, for governmental channels afford the only practicable means of protecting American property with a present value of over $25,000,000 and a prospective value many times greater against the vagaries of the Lower Colorado River in Mexican territory. It is earnestly hoped that the next Congress will make suitable provisions for rationally dealing with the matter—not only as to engineering works but also as to maintenance, organization and administration.

A Reply to Mr. Cory's Article On Work On the Colorado River Break in 1911.

By J. A. OCKERSON,* M. Am. Soc. C. E.,
Engineer-in-Charge.

The writer has read with much interest and no little surprise the [preceding] article by Mr. Cory on the Lower Colorado River work of the past winter, and is glad of the opportunity to correct some of the many misstatements made and to discuss in a very brief way some of the theories advanced as to the proper character of work to carry to a successful conclusion the object sought, namely, the protection of Imperial Valley.

It is proper to say that my official reports have not as yet been made public, and this article is, therefore, limited to broad general statements.

The plan recommended by the writer was submitted after careful consideration of all the printed reports of work previously done in that neighborhood, reports before Congressional Committees, unprinted manuscript of competent engineers sent for the purpose of reporting thereon, and extended instrumental surveys in person covering some two months in the summer of 1910, which embraced the Colorado River for a distance of 35 miles, beginning about 6 miles below Hanlon's Heading and extending down to within 20 miles of tidewater. Many maps of early periods were also obtained and served to aid in determining the probable life of a levee built at a given distance from the river, without resorting to bank protection.

The survey comprised tertiary triangulation, levels, location and elevations of bank lines, cross-sections of the river, and adjacent land, back to a projected levee line located with tape and transit and levels covering its entire length.

Mr. Cory states that a map, such as shown in "Fig. 1" of his article, is "the same as prepared by the Mexican Company under the writer's direction, a copy of which was furnished Mr. Ockerson."

The title of the map shown in Mr. Cory's "Fig. 1" states that it is a compiled map and "the work to be done" was *not* "laid down" on that map at all. The sole purpose of "Map No. 1" was to give a general idea of the Colorado delta on both sides of the boundary line, with the location of the proposed work and its relations to Imperial Valley.

The working map was platted on a scale of 1,000 ft. to the inch, and embraced the river with its bank elevations, high-water marks, transverse sections with numerous elevations, and also elevations along a projected levee line located instrumentally in the field. For the Abejas crossing a map prepared from instrumental surveys covering the entrance to the Colorado River and the Abejas River for three miles, was platted on a scale of 500 ft. to the inch. In this survey frequent elevations and cross-sections were also determined. From a careful study of these cross-sections and consideration of the probable stability of banks above and below, the site of the closure was determined.

So much for the statement that no preliminary instrumental investigations were made.

The plans resulting from the study of all this information were submitted to the proper officials of the United States and Mexico and were approved by both. Add to that the findings of the Board quoted in part by Mr. Cory, which was unanimous, no one having "declined to sign the report," as stated, and it would seem that the plans submitted by the writer were fairly well endorsed.

Your readers are doubtless familiar with the high professional standing of the members of the Board, but it may be well to add that they were all, with one exception, familiar with the physical situation through personal investigation on the ground.

Mr. Cory states that $50,000 would be a liberal estimate of the value of what was left of the work. Again he has been misinformed. An actual survey recently made shows 17% of the levee washed away or badly damaged. The levee cost $428,000 in round numbers; that means that the levee standing intact to-day is worth $355,200,

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practically all of which can be incorporated in future work looking to the larger project of complete control of the regimen of the Colorado River to near tidewater. To this amount should be added seven miles of railway construction, ties, bridge timbers, lumber, supplies, tools, etc., now on hand, which cost, exclusive of rails and accessories, at least $75,000, all being available for future work. So instead of $50,000 we have an asset of $430,000, and instead of a balance of $100,000 we have $200,000, making total assets $630,000. It should be noted that no account of the rock-fill dam is made in this list of assets, which is quite different from Mr. Cory's statement of values.

It can be said in the most positive terms that there is not the slightest hint in the report of the Board that "work of this kind is futile" or the "situation is desperate;" neither is there any "contradiction in its recommendations."

The work recommended for the present is simply intended to meet the immediate demands, so far as funds will permit.

Mr. Cory should also have quoted the following extract from the report of the Board. "With the cooperation of Mexico, it is desirable as a feature of the permanent solution of the river problem, that the Abejas break be closed and that the levee constructed in 1911 be repaired and maintained and the Colorado River restored to its former course." Another indorsement of the plan submitted by the writer.

The disposition to endow the Colorado with extraordinary characteristics is a common one, whereas it conforms to all laws applicable to alluvial streams. Some features of its regimen are accentuated it is true. Its slope is excessive and it carries an unusual burden of sediment. Its banks are composed of very fine silt, having little cohesion, and hence are easily eroded. It runs on a ridge, like all alluvial streams, but the slope of the land back from its banks is not exceptionally great. Even so large a stream as the Mississippi has adjacent lands with slopes as great as ten feet and even more per mile. The range in elevation and depression of the bed of the Colorado, following changes between high and low stages, sometimes reaches as much as 36 ft.

The writer freely acknowledges the splendid work done by the Southern Pacific Co. and Mr. Cory in the successful closure of the break of 1906-7, and it would seem to be just and proper that the Southern Pacific Co. should be paid a fair sum for the work performed.

It is true that "every foot of the levees" which they built are in good condition to-day—the levee is really a magnificent one, covered with a heavy coat of gravel.

Although some 9 ft. in height, a considerable portion of its length has never been wet by even the greatest known flood. This may have some bearing on its stable condition. At the present time this levee is threatened with destruction through the erosion of the river bank near Mile Seven, but the C. D. Company engineers are not alarmed by this prospect since the ground on which the levee stands is above overflow. The great flood of 1909 scarcely reached the top of the river bank at that point.

It is stated that the work then done was intended to answer "until suitable provision could be made to properly care for the situation in a comprehensive manner."

This more comprehensive work was undertaken by the Government. The chief difficulty in carrying out such work lies in the fact that nothing of value can be done for the protection of United States interests except by the expenditure of large sums in Mexican territory. Eliminate the boundary line from consideration and there would be little difference of opinion as to the proper plan to pursue.

Mr. Cory states: "All of the endangered interests proffered assistance of every kind, but as a rule such offers were declined with thanks." The writer accepted with due acknowledgments the only offers of any kind that were made, viz.: by the Colorado River Land Co., which donated the right of way; the "C. D. Co.," which donated the use of its tracks and rock from its quarries. The transportation service rendered by the Southern Pacific Co. was also furnished on very liberal terms, and the steel for the Abejas railway was loaned to the Government. All other assistance was well paid for.

The writer does not agree with Mr. Cory that there is a "great question which of the two plans should be followed," and the writer has *not* "changed his mind" as to the proper plan to pursue, but still insists on the plan recommended, which, as has already been shown by quotation from the report of the Board, means "the permanent solution of the river problem."

The Board did recommend the extension of the levee to connect with Volcano Lake levee, "whatever be the treatment of the lower Colorado," thus clearly indicating that this line was merely a precautionary measure.

From the explanation already given of the extent of the surveys made previous to the development of the adopted project, it is plain that Mr. Cory's suggestion that the plan was "exceedingly unfortunate and ill advised" has nothing to justify it.

The writer was thoroughly satisfied that what he proposed to do was the "best thing possible," but he had expected to carry the work out during the low-water season, beginning early in October, 1910, whereas diplomatic negotiations delayed the work until Jan. 8, 1911, a time when the work should have been completed.

To do upwards of a million dollars worth of work in ninety days, beginning without even the nucleus of an organization, wholly without equipment, in a desert country remote from supplies, and with a very inferior class of labor, would have been something of a task even under favorable river conditions. Add to this the impending flood season and the risk was greatly increased, and postponement to another season would have been prudent, to say the least. But the writer's recommendation to this end was overruled.

Mr. Cory quotes from the report of the Board regarding the reasons why the Colorado was not restored to its former channel and says "this is entirely erroneous."

The writer can say with equal assurance that the Board stated facts. Had the work been prosecuted during the low-water season the water above the dam would have been held at an elevation below the top of the banks until the Colorado bed could scour out sufficiently to carry the low-water volume, and as the volume increased the capacity would be further increased by erosion. But as we were in the midst of the flood season, the increase in the flood volume outran the increase in the channel from erosion. Practically all of the water was cut off from the Abejas River by the dam for over two weeks. At one time the volume in the old channel reached 9,000 sec. ft., which is about double the low-water volume, but by this time the total flow had reached 28,000 sec. ft., or seven times the low-water flow.

The capacity of the old channel continued to increase, but not rapidly enough to keep pace with the increase in volume, and here lies the prime cause which prevented making the closure effective.

The writer agrees with Mr. Cory that levee construction without provision for maintenance is futile, but unfortunately the matter of maintenance was interpreted as not coming under the authority of the appropriation or the negotiations with Mexico.

The levee was built with a grade of 5 ft. above the high-water marks along the river banks and *not* those along the levee line. Fortunately the

Fig. 1. Unloading Large Rock at Bee River Dam.

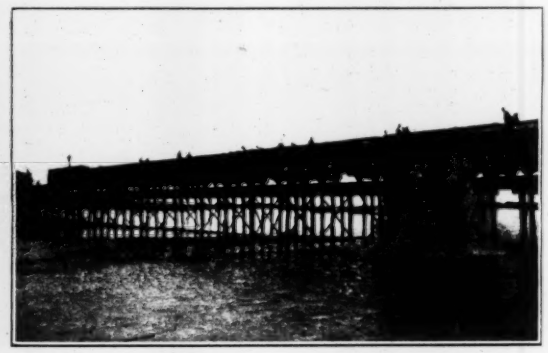


Fig. 2. Blanketing Entire Cross-Section With Rock, the Fill to be Carried up Uniformly.

Fig. 3. Abejas River Dam, March 1, 1911.

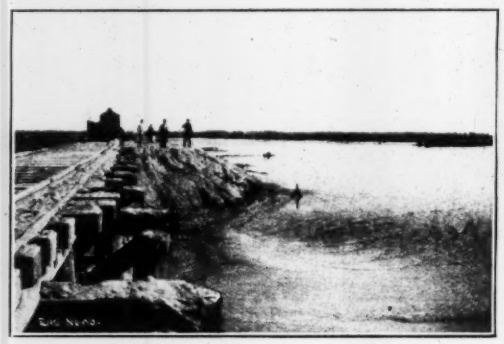


Fig. 4. A 70-ft. Blow-Out of Rock-Fill in Diversion Dam at North End of Trestle, April 4, 1911.

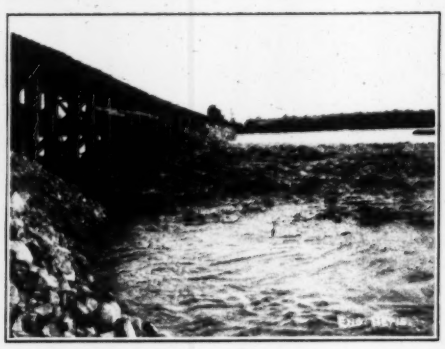


Fig. 5. Water Rushing Through Trestle, Showing Difficulty in Closure After Weir Has Been Destroyed by Break.

FIGS. 1 TO 5. INCIDENTS IN THE WORK TO CONTROL THE FLOW OF THE LOWER COLORADO IN 1911.

marks of the great flood of 1909 could be easily distinguished so the data were by no means "meager."

If the alinement of the levee should follow near the banks of the crooked stream, the yardage would materially exceed the yardage of a straight levee of greater height. The latter would have the decided advantage of being safer from bank erosion and would also give more room for the flood volume. The description given as to the elevations obtained and the examinations made, fully contradict the positive assertion that "this was not done."

A "careful study" *was* made and in the opinion of the writer an "economic location" *was* found and no better levee was ever built of the material at hand than this one.

Mr. Cory says the "immediate cause of the disaster was the borrow pits" which were on the river side of the embankment. Let us look at the existing levees that have been built in that locality.

On the Arizona side, some 25 miles of levee have been constructed with material borrowed from the river side, and while this is some of the earliest work done along the Colorado River, it has never been breached except by caving river banks. Furthermore, it is a dirt embankment, without any gravel or other covering and has been exposed to the same flood currents as the gravel-covered levee on the opposite bank and "immediate disaster" has not overtaken it.

The first closure made by the Southern Pacific Co. failed shortly after its completion, and it is well known that the prime cause of failure was the lack of muck ditch, proper preparation of the foundation of the levee, and a continuous borrow pit on the land side.

The writer examined the situation shortly after the break and was then, and still is, of the opinion that the chief cause of disaster was the borrow pit on the land side. At all events, these defects were all remedied in the next closure, which proved in every way successful.

Let us go still further. Three-fourths or more of the entire levee described by Mr. Cory as being in perfect condition has the borrow pit on the river side.

That portion of the levee which was constructed with material from the land side has been regarded with suspicion ever since it was built, and a Board of Engineers was convened to devise means to remedy the defect. Their recommendation called for artificial ramps or traverses of considerable height, located at frequent intervals and extending well across the borrow pits.

When the proposition was made to extend the levee toward Volcano Lake from the end of the levee constructed under Mr. Cory's direction, the engineer who made the report thereon prescribed traverses 50 ft. wide every 500 ft., borrow pits to be on the water side of the levee with not less than a 50-ft. berm. The Volcano Lake levee, some eight miles long, was built under like specifications.

What is known as Shoo Fly levee, which is a part of the extension toward Volcano Lake, was built in the face of a flood and they were therefore compelled to take the earth from the land side as the water was upon them before the levee was finished.

It may be well to state here that when the Southern Pacific closure was made it was realized that another break would probably occur at the Abejas River. Had the levee built at that time been extended down along the river, as provided in the recent plan, instead of turning back, there would have been no Abejas break and the story of "How the United States Spent a Million" would never have been written, and the people of Imperial Valley would now be resting in security.

Mr. Cory states that because of the "uncleared traverses the water was diverted toward the toe of the levee and rapidly eroded the river side." This is hard to reconcile with his plea for omitting clearing altogether.

The erosion of the levee was not due to "uncleared traverses" but to lack of proper brush tapoons extending from the traverses well up along the slope of the embankment, and these were deemed by the writer essential to the preservation of the levee, and the information obtained by Mr. Cory from a workman to the effect that they were not a part of the plan is erroneous. If he had applied to the engineer in charge for this and other information, which it is perhaps charitable to say has misled him, this answer would have been much abbreviated.

The foreman "in charge of the work on the dam" was at all times strictly limited to that work and had nothing whatever to do with the levee while the dam work was in progress.

Mr. Cory says that if the river line is built it will be impossible to incorporate in it more than about 4½ miles of the remaining levee. North of the Abejas River the extent of the damage to the levee amounts to 3,600 cu. yds. between Miles 7 and 8. With that exception the levee is intact for a distance of 10½ miles. South of the Abejas River the levee is intact for a continuous stretch of over eight miles, or a total of 18½ miles, which can and will be largely incorporated in any future work along this plan, instead of 41½ miles, as stated by Mr. Cory.

It would be a bold contractor who would undertake to build that amount of levee for "less than $50,000."

The railway was *not* cut by the overflow, as

Fig. 6. Break in Levee North of Abejas River, Showing Four Months Growth of Vegetation Along Right-of-Way.

stated, until after the dam was completed to the desired grade.

The writer regrets exceedingly that it has been necessary to correct very many of the statements made by Mr. Cory, and that there is only one subject on which we are agreed, and that is, that ample protection should be provided for the river slope of levees built in the district under discussion and provision for maintenance should be made. In the writer's opinion, rock or gravel is not absolutely necessary.

By the time a levee is a year old the vegetation along the berm, and sometimes even in the borrow pits, becomes so dense that a rapid flow of water becomes impossible. (See Fig. 6, showing vegetation after only four months.) Supplement this with occasional spurs of earth or brush along the levee and little danger of erosion of the embankment need be apprehended.

The work contemplated with the remaining part of the appropriation will be devoted to the slight repairs needed to the levee north of the Abejas River and raising Volcano Lake levee some 3½ ft. and covering the water face with stone riprap, owing to the entire absence of vegetation. This will give protection until provision to carry out the larger plan can be made.

In closing, it is well to say that in my opinion there is nothing whatever in the problem of protecting Imperial Valley which is not amenable to solution if properly treated. The diversion of a stream like the Colorado back to its abandoned bed requires a rock-fill dam, with facilities to deposit rock more rapidly than the exceedingly swift current can carry it away. It requires that the work should be done during the low-water season, both in the interests of economy and safety. It requires that levees should be built as described herein and that such protection should be provided as may be necessary to prevent rapid flow of water along the base. Given a moderate amount of money and the necessary authority from Mexico to build and *maintain* such work and the engineer will readily find means to secure the desired results.

The writer has no apologies to make for his share in the work, but submits these statements of fact, which are more fully set forth in the official reports, with the utmost confidence that the readers of Engineering News will uphold a fellow engineer, whose work has also been commended by an unbiased Board composed of men of the highest professional standing who state:

> The members of the conference desire to call attention to the fact that the plan and execution of the work accomplished during 1911 followed well-established principles of good engineering. That so large an amount of work was accomplished in such a brief space of time is worthy of the highest commendation.

General Features of Bull Run Conduit No. 2, Water-Supply of Portland, Ore.

By D. D. CLARKE,* M. Am. Soc. C. E.

The following notes on the new Bull Run Conduit just completed to supplement the volume of water-supply of Portland, Ore., will give a general idea of the work.

The city of Portland, Ore., secures its water-supply from Bull Run River, which has its source in the Cascade Mts., about 15 miles northwesterly from Mt. Hood. The intake is at a point 24 miles from the city limits at an elevation of 720 ft. above city datum.

The original conduit was completed in 1894, and consists of 10 miles of 42-in., 8 miles of 35-in. and 6 miles of 33-in. riveted steel pipe. Its capacity is 22,500,000 gals. in 24 hours.

The new conduit has a capacity double that of the original conduit, and consists of 10 miles of 52-in. and 14 miles of 44-in. lock-bar pipe. The 44-in. portion is constructed of ¼-in. plates; the 52-in. line vary from ¼-in. to 7/16-in. plates—the latter covering a length of but a few hundred feet at the crossing of the Sandy Canyon.

The new conduit is located practically parallel with the old conduit and but a few feet distant therefrom. The three steel truss bridges (100-ft., 200-ft. and 300-ft. spans) constructed for the original conduit, were also used for the crossing of the new conduit over Bull Run and Sandy rivers.

The contract for the new conduit was awarded to the Schaw-Batcher Co. Pipe Works, of Sacramento, Cal., in March, 1910, for the sum of $1,259,782.

The pipe was manufactured by the East Jersey Pipe Co. at its works in Paterson, N. J., and shipped by cars to Gresham, Ore., on the line of the proposed work. From this point the pipe was hauled with auto trucks and wagons to the line of the trench. The work of pipe laying was actually commenced Aug. 8, 1910, and the line was completed and the first water reached the city reservoirs at Mt. Tabor on Sept. 6, 1911.

At the headworks a temporary connection has been made with the intake constructed for the original line, the inlet being 42 ins. in diameter, or 10 ins. less than the diameter of the new pipe. The capacity of the conduit under these conditions is 44,250,000 gals. per day. This amount will be appreciably increased upon the completion of the new and larger intake basin which it is proposed to construct at some future time at an elevation 30 ft. above the present works.

The growth of the city has been exceptionally rapid during recent years, and the completion of the new conduit now insures a continuance of the same bountiful supply of Bull Run water which for years has been one of Portland's most valued assets.

A notable incident in connection with the construction of Conduit No. 2 was described by Mr. J. C. Stevens, Assoc. M. Am. Soc. C. E., in Engineering News of July 27, 1911, under the title, "Collapse of a Steel Water Conduit from External Air Pressure While Under Test."†

*Engineer Water Board, Portland, Ore.

†A general description of the Portland waterworks, by W. P. Hardesty, appeared in Engineering News for Feb. 6, 1908.—Ed.

What Gage Should be Made Standard on Australian Railways.*

By JAS. ALEX. SMITH.†

The writer has already adverted to the prime necessity for unity of gage throughout Australia, and has adduced reasons. Public opinion is crystallizing, and the question is becoming, not, shall there be a uniform gage? but, which shall be the gage?

Premises:

1. Unification of Australian railway gage is an ultimate economical, and an immediate defence, necessity.

2. Present action must profoundly, and almost unalterably, dominate the future of Australian transport.

3. All gages are arbitrary, and their efficiency is dependent upon conditions which may, and do, alter.

4. Since the 4 ft. 8½-in. gage came into general use, more than half a century ago, the change of conditions has been profound.

5. Manifestly the change is in the direction of an ever-increasing intensification of the services required.

Admitting the premises, the solution is contained in the answers to the questions:

Is the gage selected half a century ago, and adequate to the then requirements of Britain, adequate now to meet the requirements of larger countries? Will it remain adequate?

The Australian mainland has an area of 2,948,366 sq. miles, a population of 4,188,000, and a railway system of 16,756 miles, i.e., 14,996 miles of Government, and 1,760 miles of private railways. The area (2,974,159 sq. miles) of the United States is almost identical, and it most nearly parallels the Australian conditions. In 1854 the American railway mileage was equal to that of Australia today. Its population was about 26,000,000. Now with 238,356 miles of railway, its population exceeds 91,000,000.

Australia's development is but beginning, and in these experiences of other lands we can see ourselves at a later date.

By far the greatest portion of the world's mileage is of the 4-ft. 8½-in. type. There are few wider gages.‡ Virtually none of the heaviest and fastest traffic is attempted on narrower gages. But the apparent deliberate perpetuation of the choice is but an automatic continuation of that which is in other lands—but not here—unalterable. The origin was not a manifestation of fundamental law; it was wholly fortuitous. The stone ways laid in some of the older English roads probably owed their spacing to the distance apart of the wheels of the Roman chariots. The first collieries to use rails of wood spaced them similarly. Later the wood was armed with strips, or "plates," of iron narrower than the original wooden rail. Over these lines the first locomotives ran. The first railways duplicated that tire spacing, and the 4 ft. 8½-in. gage was born.

The only serious rival of the 4 ft. 8½-in., or "narrow," gage was the 7-ft., or "broad" gage. The Great Western was of the latter type; others of the same width were projected. At once it was recognized that there must be uniformity, and the "battle of the gages" ensued.

Then there were no data which could, in any sense, guide the engineer of the new transportation. The contestants were guided only by the light of the then simple traffic conditions and were in entire ignorance of lengths of haul greater than those possible in Britain. The "narrow" gage was victorious, but by a narrow margin only. Even than it was considered that the greater advantages of the broader gage would almost justify its greater cost. Had the contest been between the "narrow" gage and lines of 5 ft. 3-in., 5-ft. 6-in., or even 6-ft. gage, it is almost certain that the "narrow" or 4-ft. 8½-in. gage would have been defeated in Great Britain.

In the 50's, far-seeing advisers of the Australian colonies, who had a near acquaintance with the merits of the gage controversy, decided upon the broader "Irish," or 5-ft. 3-in. gage. The colonies of New South Wales, Victoria, and South Australia endorsed the choice, and made it the standard—in New South Wales by Act of Parliament. Possibly an even wider gage might have been recommended had rolling stock of wider gage been a market article.

Victoria and South Australia abode loyally by the contract, and commenced construction. Then New South Wales changed its policy, its engineer, and its gage, and the unique opportunity for obtaining uniformity was wilfully thrown away. Since then various other gages have been introduced on the plea of their suitability for cheap pioneer development. That claim—temporary expediency—is the only valid reason for their introduction.

The position is given in the following table:

GAGE AND MILEAGE OF AUSTRALIAN RAILWAYS.

	Length of the Several Gages in Miles.					
State.	5ft. 3in.	4ft. 8½in.	3ft. 6in.	2ft. 6in.	2ft. etc.	Total.
New S. Wales	45	3,824	39	...	...	3,908
Victoria	3,435	....	....	107	...	3,542
S. Australia..	599	....	1,371	...	...	1,970
W. Australia.	....	....	2,924	...	62	2,986
Queensland .	....	....	4,125	...	80	4,205
N. Territory.	....	....	145	...	...	145
Totals.....	4,079	3,824	8,604	107	142	16,756

Merits of the Gages.

Any rectification clearly implies a change of the greater proportion of the lines of Australia. Least change would follow the adoption of the 3-ft. 6-in. gage, which constitutes the greatest mileage. There are those who hold that gage sufficing, even for transcontinental trunk lines. There are other advocates who contend for a differentiation of states, and a duality of gages—a doctrine opposed to the experience of the world and the future welfare of this continent.

It would be against self-apparent facts to contend that the 3-ft. 6-in. could handle the heavy and fast traffic which the broader gages of New South Wales, Victoria and South Australia must, and do, handle. And it would be against all the indications of probability to contend that, at no distant date, similar traffic will not be general.

World-experience shows that the 3-ft. 6-in. must be eliminated as a national gage for long hauls or important lines. The issue is thus narrowed to 4-ft. 8½-in. versus 5-ft. 3-in., although posterity may blame us for not seizing the opportunity to secure an even broader gage.

Any difficulty in selection is dependent upon the similarity of the gages—they differ by but 6½ ins. Were the difference greater, the advantages and disadvantages would be accentuated, and choice would be simpler. There is no question as to the magnificent work possible on either. There is no question that in Australia the possibilities of either are very far indeed from exhaustion. Again, reliance must be placed upon the trend and limitations of thought and practice abroad.

LENGTH OF HAUL.—But comparisons must be made with caution and reserve. Australia is a continent. The coast to coast distances are great. The interior can only be reached by long hauls.

Wherever such conditions arise, financial success has been sought in the direction of increasing the train weights and decreasing the relative number of trains run, in an endeavor to minimize labor costs and ensuing expenditures. The United States again furnish the nearest parallel. There freight trains have attained abnormal weight. They are drawn by locomotives twice, and even thrice, the weight of the heaviest Australian engine. All this on the 4-ft. 8½-in. gage, and until we have reached a similar intensity of traffic, that gage would suffice here.

But the Americans, pressed as we are not yet pressed, find that the gage is reaching an economic limit, and many leading men voice the opinion that were choice again theirs—as it cannot now be—a wider gage would be selected.

Average length of freight haul for various countries, from actual traffic returns (1908), are as follows:

	Miles.
United Kingdom	25
Russia	152
Germany	62
France	78
Austria	65
Canada (Companies)	183
Canada (Government)	234
Argentine	63
United States	132

In 1897 a railway commission met to determine the relative costs of conversion of the 4-ft. 8½-in. to the 5-ft. 3-in. gage, or vice versa, in the colonies of New South Wales, Victoria and South Australia. The mileage then involved, considered as single track, totalled 7,849, as against 9,407 now, the length to be altered being dependent, of course, upon the gage selected. The conversion costs, including rolling stock and all charges, were estimated to be:

4-ft. 8½-in. to 5-ft. 3-in.....	£4,260,000
5-ft. 3-in. to 4-ft. 8½-in.....	2,360,500
Difference.....	£1,899,500

The difference was of the order of 2% upon the capital value of the property. Now, that estimat included provision for the re-sleepering of the 4 ft. 8½-in. lines, conditional upon their conversio of 5 ft. 3 ins.

But the larger cost of conversion is connected not with the conversion of the broader gages, bu with the conversion of the 3 ft. 6 ins., to either Especially is this the case when, in location, i cuttings, embankments and bridges, and in permanent works generally, short-sighted policy has ignored the possibility of a subsequent substitution of a line of greater capacity.

In previous estimates provision has been included for widening of certain tunnels, standing works, etc., as a sequence to the adoption of the broader gage; but the question is, would not these alterations become ultimately a necessity, altogether apart from the question of gage? There is no doubt that the earlier administration did not look far enough ahead in limiting the width of the right-of-way by these encroachments. Already the pinch resulting from insufficient clearance is felt, not on those sections only in which they exist, but in regard to the whole rolling stock which may at any time traverse them.

Probably most mechanical engineers who have specialized in locomotive and rolling stock design, would assert the invaluable advantage of the added 6½ ins. permitted between frames as a consequence of greater gage. They know that it means the possibility of the use of internal cylinders, of greater grate area (at lower level) and boiler capacity, matters which concern not only the power of the engine, but the endurance of the road. The force of this contention is not at all lessened in respect to engine practice here by the fact that locomotives of far greater power are elsewhere running on 4-ft. 8½-in. roads.

The writer is strongly of opinion that the merits are with the 5-ft. 3-in. gage.

Differences of cost of conversion in the present are as nothing in comparison with the larger problems of the near future, which they will dominate. Those who approach the matter, must, of necessity, think in millions, and must be prepared to sink heavy sums to save or gain greater amounts.

There is, as yet, no evidence that the suggestions which have been made as to gage, and those which have received tentative official endorsement, are based upon facts which are conclusive, or upon the exhaustive consideration such a momentous question demands.

Whatever gage the representatives of the engineering profession may endorse, it is certain that the decision will be historic, irrevocable, and probably more far-reaching than any other supposable in Australian engineering.

*From a paper read before the Victorian Institute of Engineers, Sept. 6, 1911.

†President Victorian Institute of Engineers, Melbourne, Australia.

‡In several countries where the area is great, and where recent choice has been possible, wider gages have been adopted; for instance, Russian and Russo-Asiatic lines 5 ft. 3 in. and 5 ft., Indian trunk lines 5 ft. 6 in., Argentine, 5 ft. 6 in.

Statistics of the Manufacture of Coke in the United States are given as follows in a preliminary report of the U. S. Census Bureau for the year 1909. Gas-house coke statistics are not included, being given separately in the gas manufactures' report.

	1909.	Per cent. of increase, 1904-1909.
Number of establishments....	315	13
Capital	$152,321,000	68
Cost of materials used.....	$64,025,000	114
Salaries and wages...	$17,526,000	66
Salaries	$2,072,000	66
Wages	$15,454,000	66
Miscellaneous expenses	$3,288,000	*33
Value of products.....	$95,697,000	85
Value added by manufacture (products less cost of materials)	$31,672,000	45
Employees:		
Number of salaried officials and clerks	1,852	34
Average number of wage earners employed during the year	29,273	54
Primary horsepower	62,602	*6

*Decrease.

The quantity of coke and by-products produced is given as follows:

	1909.*	Per cent. of increase, 1904-1909.
Coke (tons 2,000 pounds)....	39,315,065	59
Beehive	33,060,421	47
Retort or by-product.....	6,254,644	182
By-products obtained from retort or by-product ovens:		
Gas made (1,000 cu. ft.)....	76,590,763	308
Used in process or wasted	60,799,543	309
Sold	15,791,220	307
Tar (gallons)	60,126,006	161
Ammonium sulphate (lbs.).	123,111,197	373

*Includes quantity of coke and by-products from retort ovens produced by establishments engaged primarily in the manufacture of other products, the value of which—$2,343,000—is not included in the general summary above.

Operating Statistics of the Municipal Electric Plant of Pasadena, Cal.

In Engineering News, Feb. 10, and April 7, 1910, the operating statistics of the Pasadena Municipal Electric Plant for the year ending July 1, 1909, were discussed. The data were of unusual interest on account of the low rates for the municipal service which was competing with that of a large company supplying Pasadena and neighboring cities. There has been a continual reduction in rates since then in spite of which the local plant has been operated with apparent success and growth. The rates are as follows:

	Incandescent lighting.	Street lighting.	Power.
Up to 100 KW.-hrs. per mo.	5 cts.	.....	4 cts.
100 to 500 KW.-hrs. per mo.	4.5 "	.....	2.4 "
500-1,000 KW.-hrs. per mo.	4 "	.....	2 "
1,000-2,000 KW.-hrs. per mo.	3.5 "	.....	.....
Over 2,000 KW.-hrs. per mo.	3 "	.....	.....
1,000-1,500 KW.-hrs. per mo.	....	.....	2 "
1,500-5,000 KW.-hrs. per mo.	....	.....	1.9 "
5,000-10,000* KW.-hrs./mo..	....	.....	1.75 "
5,000-10,000† KW.-hrs./mo..	....	.....	1.5 "
Over 10,000 KW.-hrs./mo..	....	.....	1.5 "
6.6-amp. arc lamp per year	....	$60.00	.....
40-c. p. Tungsten lamp/year	....	12.00	.....
80-c. p. Tungsten lamp/year	....	24.00	.....
Cluster posts, per KW.-hr. plus renewals	....	3 cts.	.....

*If used between 5 p. m. and 10 p. m.
†If not used between 5 p. m. and 10 p. m.
Monthly lighting-service meter charge: 75 cts. per meter up to 3-KW. capacity and 30 cts. per KW. additional. Monthly power-service meter charge: $1 per meter up to 1 KW. capacity and $1 per KW. additional.

The operation of this municipal enterprise has attracted so much attention that the following figures, from the report of Superintendent C. W. Koiner for the year ending June 30, 1911, are of timely interest. The plant is steam driven and uses oil fuel; the present capacity is 1,500 KW. and 1,500 KW. machinery is now being installed. There is a total length of 716 miles of wire on 4,450 poles; the distributing system carries 2,331 KW. in transformers and the 3,920 meters have a total capacity of 4,000 KW.

EXPENDITURES:		
Manufacturing:		
Fuel		$20,559.22
Lubricants		1,040.65
Wages at station		5,281.79
Water		34.70
Miscellaneous supplies		1,188.11
Repairs to building		312.16
Repairs to machinery		2,070.42
		$30,487.05
Distributing:		
Mainten'ce & repairs less inventory		$11,979.10
Management:		
Salaries		9,061.89
Advertising, etc.		2,752.91
Supplies		2,111.26
		$13,926.06
Total of operating		$56,392.21
BONDS:		
Av. investment for year		$462,639.60
Value of plant, July 1, 1911		484,750.93
Outstanding bonds 4%		251,875.00
Outstanding bonds 4½%		46,250.00
Bonds paid 1910-11		8,125.00
Interest 1910-11		12,387.50
EARNINGS:		
City street lighting		$38,422.37
City buildings		1,068.34
Commercial		70,520.39
Total		$110,011.10
Excess of earnings over operating expense		$53,618.89
Surplus over expenditures		$33,106.39
OUTPUT:		
Net KW.-hrs. generated		2,763,872
KW.-hrs. per bbl. oil		120.9
Manufacturing cost per KW.-hr.		1.103 cts.
Distributing cost per KW.-hr.		0.937 ct.
Management and bond interest cost per KW.-hr.		0.953 ct.
Total cost per KW.-hr. exclusive of depreciation		2.49 cts.
Effy. of distributing system		84.2%
Ratio operating expense to gross revenue		50.7%
Unaccounted current		15.8%

The above figures allow computing other statements which are more directly comparable with good operating results of central stations. For instance, no depreciation is allowed, but the $8,125 redemption of bonds is really a straight-line amortization of 1.7%, the average investment for the year. A surplus of $33,106.39 is shown above all expenses, including bond interest and redemptions. This was put into plant extensions and constitutes a further allowance for depreciation of 7.15%. Much of the money needed for extensions has thus been furnished by earnings. Plant upkeep is aimed at 100% of original condition so that in "repairs" are many items usually kept as "renewals." Looking from another point of view, the $53,618.89 excess of income over operating expenses amounts to 11.6%—which may be split into 4% earnings on investment and 7.6% depreciation, or otherwise as deemed more comparable with other cases.

In previous years criticism has been made of an apparent excess unit cost of current for street lighting. The 1911 report shows receipts of $0.0522 per KW.-hr. from street lighting and an average of $.0456 from commercial customers.

An Electric Motor-Truck Crane.

One of the most recent developments in motor trucks is an electric truck with a swinging crane mounted at its forward end for use in handling and moving freight or materials in warehouses and shops. The hoist, of one-ton capacity, has its winding drum mounted on the platform of the truck, just behind the crane, as shown in the accompanying illustration. The foot of the boom has a large ball-and-socket bearing. The hoist is controlled by a single lever. It has an automatic holding brake and a load brake to prevent excessive speed when lowering. The hoist motor and the propelling motor for the truck both take current from the storage battery at the rear end.

Perhaps the most obvious use of this truck is in loading or unloading cars, wagons and lighters. Material in parcels of one ton or less can be raised through a vertical distance of 10 ft. and deposited anywhere within a 6 or 8 ft. radius by swinging the boom of the crane without moving the truck itself. The truck can be held stationary during such work by setting the brakes. The following data are given of the truck's performance at this class of work:

Five hundred castings aggregating 65,000 lbs. were unloaded from a gondola car in five hours, giving an average of 1.2 lifts per minute. A box car was loaded with 64 800-lb. bbls. of plumbago in 25 minutes, and four cars were loaded in 2½ hours, the latter work including spotting the cars. This averages 2 bbls. per minute hoisted nearly 5 ft. and swung well inside the cars.

When material has to be moved less than 400 ft., or in small quantities to any distance, it can be conveniently carried hanging from the crane hook (see illustration) and can be put down at its destination at any height above the floor within the crane's limits. The truck is the better suited for this class of work by its short wheel-base which permits of short turns so that the machine may be driven more readily about shop aisles and among piles of material. It is claimed that much heavy errand work can be found for this machine, even in factories already equipped with cranes and industrial railways. The following data are given for this class of work:

Sixty 800-lb. bbls. of plumbago were moved 300 ft. in one hour, one helper only being required. One hundred and fifty 300-lb. boxes of rubber were conveyed 75 ft. and loaded into a box car in 50 minutes, three boxes being slung together and a round trip made every minute. In a store room, boxes of angle and flat iron weighing about 1,000 lbs. each were carried 30 ft. and stacked in sorted and orderly piles at the rate of 40 boxes an hour. One-ton rocks were loaded onto trailers from a scattering pile at the rate of 24 an hour, being hoisted 2 ft. and carried about 20 ft. in the operation. Two 1,200-lb. water meters were lifted from a hole 6 ft. deep and carried to the shop bench a thousand feet away in 30 minutes.

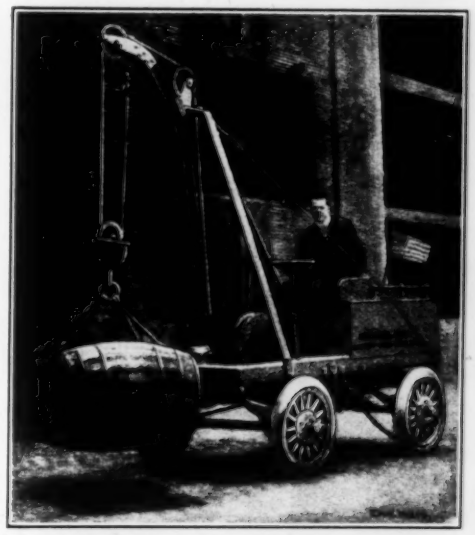
The truck is not arranged to carry heavy loads itself, but is intended for use in towing trailers whenever the distance to be traveled is such that this method is preferable to that of transferring the material in small lots suspended from the crane hook. The limiting distance for economical work without trailers is put at about 400 ft., that is, where large quantities of freight are involved. The truck is designed for a high drawbar pull (2,000 lbs. maximum), to suit it for trailer towing. This pull is about equal to that of a five-ton locomotive on rails, and is sufficient, it is claimed, to handle loads of from five to eight tons on trailers. On account of this high tractive force, the truck can be used for spotting cars and may prove useful for giving assistance to overloaded wagons or automobiles.

A special form of trailer has been designed for use with this truck, having a capacity of three tons. The deck, 12 ft. × 4 ft., is at a height of 29 ins. above the ground. The wheels are 24 ins. in diameter, with a 5-in. face and are mounted on roller bearings. A heavy towing tongue is provided with arrangements for easy coupling to the motor truck or to another trailer. It is claimed that the trailers follow truly in the track of the truck, so that no difficulty is found in towing a number of them even around obstructions.

Four trailers is the usual number in a train for long hauls, but this can be varied to suit the conditions. When there is a sufficient amount of work to be done to make it pay, time can be saved by using three trains of one to four cars each. One train is then being loaded and another unloaded, while the third, either empty or loaded, as the case may be, is on the way between. In this way, a maximum of 600 sq. ft. of loading deck can be kept working to its full capacity.

Data of the truck's work with trailers are given as follows:

Six hundred thousand pounds of cotton have been moved one-half mile in a day (10 hrs.), taking 24 bales per load and making a round trip every twelve minutes. This gives an average of two bales (600 lbs. each) per minute moved a distance of one-half mile. On a hurry order for cotton, 48 bales (12 tons) were delivered alongside the lighter within 25 minutes after the order was given. One truck using three trailer trains of two cars each has moved 1,000,000 lbs. of small package freight (canned salmon) 600 ft. in 9 hours.



(Capacity of crane, one ton; drawbar pull of truck, for towing trailers, 2,000 lbs. Made by General Electric Co., Schenectady, N. Y.)

Motor-Truck Crane for Shops and Warehouses.

The following represents an average week's work at towing trailers in the Bush Terminal, New York, deduced from the logs of a number of these machines operating over a long period:

Number of packages handled	7,570
Average weight per package	230 lbs.
Total weight handled (900 tons)	1,720,000 lbs.
Average distance packages were moved	900 ft.
Per cent. of total time machine was working	80%
Packages delivered per working minute	3
Number of different jobs worked on.	30
Heaviest single load drawn	12½ tons
Cost of operator, interest, depreciation, power	$24.00
Cost of moving one package 900 ft.	½c.
Cost of moving one ton (9 packages) 900 ft.	3c.

The truck crane is made by the General Electric Co. of Schenectady, N. Y., to which we are indebted for the information for this article.

The Sunnyside Terminal Yard of the Pennsylvania R. R. Co., at Long Island City, handles the trains on the Long Island R. R. lines which terminate at the new Pennsylvania R. R. station in Manhattan and at Long Island City. The yard contains 34 tracks, receives about 60 trains a day and dispatches a like number. About 400 cars a day pass through the yards and about 1,000 men are employed in them.

A Difficult Piece of Diamond Drilling.*

When diamond drilling explorations are undertaken from the surface, stand pipe must be sunk to bed rock or ledge through the overlying deposits, which may consist of soil, sand, clay, gravel, boulders, etc. This overburden may vary in depth from a few feet to several hundred feet. Many deep stand pipes have been sunk vertically, and stand pipes at an angle through light overburden, are common and present no extraordinary difficulty. Deep stand piping at an angle is, however, an unusual undertaking and requires much skill and experience as well as time for successful accomplishment.

A stand pipe which has been successfully driven near Ogdensburg, N. Y., while prospecting for zinc ore, presents unique features of interest. The pipe was started at an angle of 60° from the horizontal and sunk through a deposit of sand and gravel, quicksand, boulders and a mixture of mica and sand. The ledge was finally reached at a depth of 372 ft., at which point a test of the angle of the pipe showed 44°. The accompanying sketch shows the line of the pipe, as given by tests made at various depths with a hydrofluoric acid glass clinometer.

The hole was started on Aug. 4, 1910, and the line of casing reached the ledge on Dec. 10, making a total of 111 working days consumed, or an average of 3.35 ft. per working day of ten hours.

Boulders 3 or 4 ft. or more in thickness were frequently met with, making the use of the diamond bit necessary in order to place a shot to break them. Between the depths of 146 ft. and 265 ft., 50 blasts of dynamite were required to advance the pipe, employing two to three pounds of dynamite for each blast. The shots were fired with an electric blasting battery.

At one point where the formation consisted of clay, cementing was tried in an attempt to hold open the hole until the ledge was reached. It

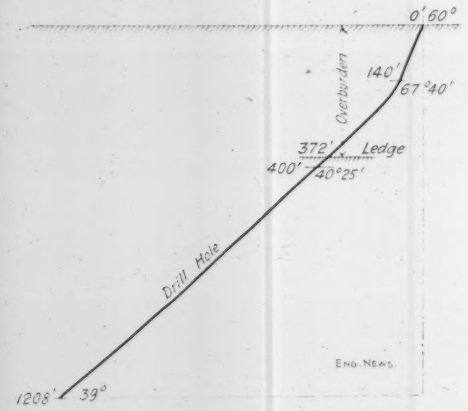


Diagram of an Inclined Prospecting Hole Put Down with a Diamond Drill Near Ogdensburg, N. Y.

was found when drilling out the cement that the diamond bit did not follow the cement core, but instead deflected into the softer clay, thus making it necessary to advance the pipe through this material.

After the ledge was reached, the casing was drilled into the limestone and cemented in place. The work was continued with the diamond bit until the hole was finished at a depth of 1,208 ft., measured along the hole. It will be noticed from the diagram that from 400 ft. to the end of the hole the angle remained practically constant, there being a decrease in the angle of but 1½° in 808 ft.

The deep stand piping in this hole was not anticipated, inasmuch as two previous holes drilled near by required only 25 ft. and 51 ft. of stand piping respectively. Hole No. 1 was drilled at an angle of 38° and hole No. 2 at an angle of 60° from the horizontal. If such deep overburden could have been foreseen, other sizes of piping would have been used in the work described above.

After the ledge was reached, and drilling started with the diamond bit in solid rock, the rate of progress was greatly increased. It required 37 days to complete the remaining 836 ft. The crew during this time worked two shifts per day, of ten hours each. The progress in this latter drilling was 22.6 ft. per day, or 11.3 ft. per shift. During this time the hole was cemented twice. The drilling from 372 ft. to the finish of the hole was mostly in limestone, although occasional wide bands of quartz, hornblende, granite, dyke, and pygamite were encountered.

The work was performed by the Sullivan Machinery Co.

*Abstract of a paper by W. T. Roberts in the August number of "Mine and Quarry" (published by the Sullivan Machinery Co., Chicago).

The Battle of the Flies: A Ballad of the Line!

By ALLEYNE WRIGHT.*

[With apologies to the late Author of "The Bab Ballads."]

In a not very distant seaport town,
  Its name not hard to guess,
On Government Street, I chanced to meet
  An elderly P. L. S.†

His wandering eye and his worried smile
  Were so very uncommonly queer
That I murmured, "I think there's excuse for a drink,
  Let us wend to a restaurant near."

Now after he's swallowed a dozen or so
  Though turning a trifle pale,
He clutched at my arm and suppressing a qualm
  Related this truthful tale:

* * * * * *

Oh, I am the picket and transit man,
  And the band of axeman three,
And the chainman, too, to complete the crew
  Of my gallant K. and E.†

It was seven o'clock on a summer morn
  With the weather uncommon fine,
That I mustered the crew (and a sandwich or two)
  And hied me forth to the line.

There was Terrible Thomas, the picketman,
  With an eye so wonderful keen,
He could see my sign at the end of the line
  With a couple of trees between.

And Trustful James, at the end of the chain,
  With a pull like a cast-iron winch,
Would measure a score of miles or more
  To the thousandth part of an inch.

And Dick and Billy and Archibald
  Were the axe men strong to see;
I ain't no kid, there was something did.
  When we manned the K. and E.

"Now Boys," I cried, as I led the way,
  "We must make a strenuous fight
For the northernmost line of Township Nine
  Must be run e'er the fall of Night."

Oh, the skeeters sang in the morning air
  As they "opened the foreign male,"
And the little black fly, with a bloodthirsty eye,
  Came peppering down like hail.

Now, we may have worked for an hour or so,
  When Billy he gave a yell,
And proceeded to say what he thought of the day
  In language imported from hell.

And Dick, whose heart was too full for words,
  Or his face too swollen to speak,
Just nodded his head, and the two of them fled
  And were off to the camp like a streak.

T'was only a hub or so beyond
  That Archibald, nearly blind,
Sat down on a bee, on the stump of a tree,
  And was stung on his—never mind.

But Terrible Thomas and Trustful James
  And me with the K. and E.
Each brandished a piece of bacon grease
  And steered for the nearest tree.

Oh, the black fly nagged in the midday sun
  Like the very hounds of hell.
The clothes we wore, they were drenched in gore
  And the sand fly came, as well.

But Trustful James, though doing his best,
  Was almost exhausted with pain.
With a feeble grasp, he would totter and gasp
  Every time we measured a chain.

It may have been three in the afternoon,
  He utters a terrible groan,
And waving his axe, his muscles relax,
  And he falls to the ground like a stone.

So only Thomas and me were left
  With the delicate question, which
Could stand the pace in that gory race
  And I argued it out as sich.

For Thomas I loved as a brother, I did,
  And Thomas he worshipped me,
But there'd soon be a mess if a P. L. S.
  Didn't run that K. and E.

So I sends him ahead to a distant hill,
  And as he's a'watching me
I yells, "You dub, take line for a hub,
  Three tacks from the bearing tree."

Three times he tried with his swollen lips
  To ask what the devil I cried him,
"No tacks," he chokes; then falls and croaks
  With his plumb-bob close beside him.

His arms they were swelled like a couple of drums,
  And the shape of his face was wrong.
It was lumpy and marred and pitted and scarred
  Like a map in relief of Mont Blong.

Alas and alack, of the gallant crew
  That started so fair to see,
There remained but one behind the gun,
  Just me at the K. and E.

But still the mosquitoes, evil spawn,
  And the black fly, as evening fell,
Continued their lays in Beelzebub's praise,
  Their anthem from nethermost hell.

Now when I had heaved the corpse off the line,
  I tackled a bunch of trees,
As the first I chops, why, I almost drops,
  For the corner in sight I sees.

So I winds the netting around my head,
  And smears on oil and fat,
And by working amain, runs both ends of the chain,
  We'll let it go at that.

I sights the picket and sets the tack,
  And measures it fair and true.
It checked to a dot, whether likely or not,
  And it's true what I'm telling to you.

And I never laugh and I seldom smiles,
  And I'm never seen to play,
But I sit and croak and a single joke
  I have—which is to say:

Oh I am the picket and transit man
  With his trusty K. and E.,
The axeman true and a chainman, too,
  The whole menagerie.

*Fraser Lake, B. C.
†P. L. S. = Provincial Land Surveyor.
K. & E. = Keuffel & Esser.

The Bureau of Public Works of the Philippine Government has the responsibility for and the direct supervision over all provincial public works in the 31 Christian provinces which require an expenditure of more than 500 pesos. It has control over all insular public works except those of harbor and port works. This authority is exerted principally through the district engineers who are also the agents of the provincial boards. The district engineers also act in municipal affairs at the direction of the provincial boards or at the request of municipal councils.

The work of the district engineers is inspected by division engineers who apply on all important work the modern test of engineering economy, viz., technical units costs. These division engineers report to the Director.

In 1910 the Bureau employed 110 engineers and 20,000 laborers and expended 8,000,000 pesos (about $4,000,000). The Bureau maintains 1,467 miles of roads and builds annually about 155 miles of new roads and 300 bridges and culverts. It is also charged with responsibility for construction and repair of public buildings, for irrigation work, for municipal water supplies and sanitation. The Director of the Bureau is Mr. Warwick Greene, a son of Gen. Francis V. Greene, M. Am. Soc. C. E., and other heads of departments are as follows: Mr. C. W. Hubbell, Chief Engineer; Mr. C. G. Wrentmore, Chief Irrigation Engineer; Mr. Claude Lindsey, Assistant to the Director; Mr. W. W. Larkin, Accountant; Mr. Max Dobbins, Statistical Engineer; Mr. C. M. Pritchett, Chief Division Engineer; Mr. C. W. Keith, Bridge Engineer; Mr. J. W. Vickers, Superintendent, Artesian Wells Division; Mr. Geo. B. Asp, Chief, Building Division; Mr. D. A. Bruen, Chief, Property Division; Mr. W. E. Bowles, Chief, Record Division; Mr. Frank P. Reynolds, Chief, Drafting Division.

A New Machine Tool for Boring Square Holes.

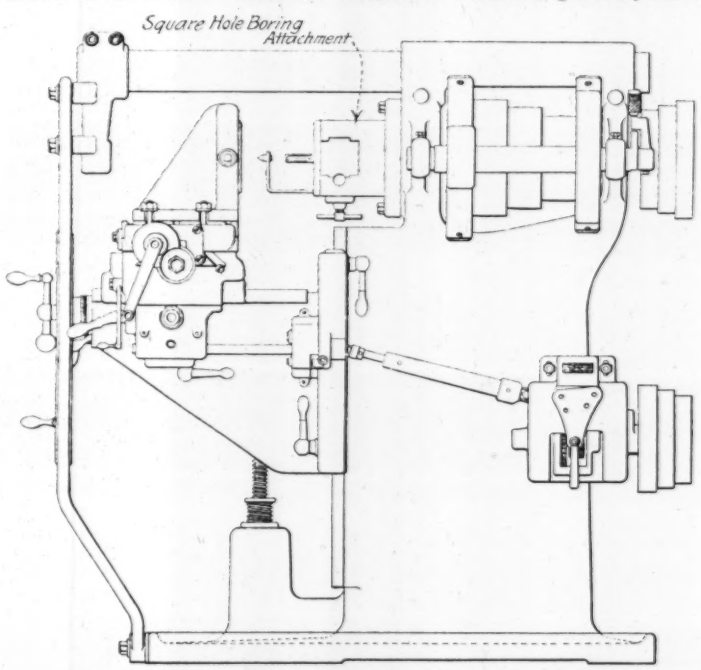
An attachment for boring square holes in wood or metals was described in Engineering News, Jan. 7, 1909, p. 24, which was made in the form of a chuck or tool holder, to be applied to the spindle of a drill press, lathe or milling machine. Three-sided drills or bits, whose shanks turned in square guide hole in the chuck, were used. We are informed by the Niles-Bement-Pond Co., 111 Broadway, New York City, that experiments with such attachments convinced them that it was hardly possible to attach the device rigidly enough to the spindle, and that the carriage of an ordinary lathe was not stiff enough to resist the side thrust and hold the work firmly in position. For these reasons, square holes bored with such attachments on an ordinary lathe in tough materials were not perfect.

As a result of these experiments, a special machine tool has been designed for the above-named company by the R. K. LeBlond Machine Tool Co., of Cincinnati, Ohio. As shown in the accompanying illustration, this tool closely resembles a horizontal milling machine, from which it differs in having provision for bolting the square-hole boring attachment to the frame of the machine at the end of the spindle. This arrangement gives the desired rigid attachment of the boring device.

A sufficiently rigid support for the work itself is obtained by means of special braces connecting the knee that supports the work table with both the overhanging arm and the base of the machine. A special vise is furnished for holding the work.

The square-hole attachment projects considerably beyond the nose of the spindle, and thus, in order to get a sufficient working space in front of the cutter, the spindle itself is set back further from the work table than in the ordinary milling machine. This does not interfere, however, with the possibility of using the machine for regular milling work. The square-hole attachment can be quickly removed, and the machine can then be used as a plain miller. It can be used, too, for drilling with an ordinary twist drill by means of a simple appliance which can be connected to the spindle without removing the square-hole chuck. Any size of twist drill can be used. Thus a round hole can be drilled first when desired and the corners cut afterward with the square-hole bit. This procedure is claimed to be advantageous in the case of the tougher materials.

A very fine feed is required for cutting square holes, for which reason two separate cross feeds are provided—one for regular milling work and the other for extra-fine feeds, starting with .001-in. per revolution. The range for boring square holes is from ¼-in. to 2 ins. square.



MACHINE TOOL FOR BORING SQUARE HOLES UP TO 2-IN. DIAMETER.
(Can be used also as a plain miller.)

The Underwriters' Laboratories, Inc., is celebrating the tenth anniversary of its corporate existence. This is a testing station operated under the direction of the National Board of Fire Underwriters for determining the value of materials and devices in the prevention of fire. The plant has grown to cover an area of 25,720 sq. ft. from the original area of 4,000 sq. ft. There are 54 employees at the home office, where there were nine, and 34 offices exist in other cities where ten years ago there was none. Approximately 20,000,000 labels are used per year on approved materials and devices, where there was none used before, this practice having been developed since the inception of the laboratories.

Deflocculation.*

By EDWARD G. ACHESON,† M. Am. Soc. Chem. Eng.

Having worked out the problems involved in the manufacture of graphite from coal and other carbonaceous materials, I undertook, in the Summer of 1901, the introduction of this artificially made graphite into the crucible trade. My first efforts were devoted to the making of a satisfactory crucible of my graphite, using as a binding material American clays. Many failures were met with, and I found it difficult to locate the cause of the failure, whether with the graphite or with the clay. I soon learned the manufacturers of crucibles in the United States invariably used as a binding agent for the graphite in the crucible body, clays imported from Europe. I secured samples of these imported clays, and found them much superior to the American ones in plasticity and tensile strength.

Chemical analysis failed to disclose the cause of the physical differences existing in the clays. The question involved interested me greatly, and I decided to endeavor to determine what produced the variations. I found it generally stated in the books that residual clays were non-plastic, and sedimentary clays were more or less plastic. Here was the starting point. Plasticity was developed by or during the act of transportation from the point of formation to the final resting place of the clay. I did not believe there was anything in the simple act of the suspension in water that would produce the effect noted, and therefore looked for the cause of the foreign matter carried by the water. It seemed the most likely agents were the organic substances washed from the forests into the running waters. With this idea in view, I made a few experiments with those substances I thought likely to be found in the washings of vegetation. One of my early experiments was to treat kaolin with a solution of tannin, and I at once noticed less water was needed to produce a given degree of fluidity; also that the tensile strength and plasticity were increased.

Tests were made on the increased tensile strength of clay, as the result of treatment with organic matter, and it was found that briquettes made of Harris kaolin and dried at 120° C. would break with a load of 5.73 kilograms per square centimeter, while the same clay, after treatment with 2% of catechu for a period of ten days, then formed into briquettes and dried at 120° C., would not break until the load was increased to 19.75 kilograms per square centimeter—an increase of more than 244%.

*Extract from a paper read before the Society of Chemical Industry, at London, Nov. 7. See also paper by Mr. Acheson before the American Institute of Electrical Engineers in Engineering News of Aug. 1, 1907.

†Niagara Falls, N. Y.

I now began to wonder whether or not the effect I had discovered was known, as it might have much value to an industry of such colossal dimensions and antiquity as clay working. Moreover, it would be amazing if it should not be known, in view of the tremendous amount of experimental work that had been done on that art. I searched for some record of the addition of organic matter to clay during its working, and only one instance could I find, that of the Egyptians in brick-making, as recorded in the Fifth Chapter of Exodus. The accepted theory of using straw fiber as a mechanical binding agent had never appealed to me. Straw, however, contains no tannin, and the effect I had found had always been produced with tannin, or a substance containing tannin. I procured some straw, boiled it with water, decanted the resultant reddish brown liquid, and mixed it with clay. The result was like that produced with tannin, and equal to the best I had obtained. It now seemed likely that the Egyptians were familiar with the effect I had discovered, and believing this was why they used straw in making brick and were successful in substituting stubble for the straw, I called clay so treated "Egyptianized Clay."

In the Summer of 1906 I succeeded in making artificially a high grade graphite which I wished to make applicable to all kinds of lubrication. To meet the various demands, it would be necessary to have it remain diffused in liquids lighter than itself; for instance, water and petroleum oils. Recalling the effect of tannin on clay, which caused it to remain diffused in water, I treated a sample of my graphite with tannin, and found the same effect occurred.

Upon being deflocculated, the graphite is diffused through the water in a colloidal state, and I have samples of deflocculated graphite in water which have stood for more than two years without showing any settling, notwithstanding the graphite is 2.2 times heavier than water.

I have been able to obtain this same effect on natural graphite, amorphous alumina and silica, lamp black, and my manufactured product—Siloxicon, which is an amorphous body having the formula Si_2C_2O. The effect can be produced with a long list of organic bodies; for instance, tannin or organic substances containing tannin, also with solutions containing the gum of the peach and cherry tree, or extracts from straw and grass. The offal from the barnyard proved to be very efficient. I speak of these organic substances as agents when used to produce deflocculation, and they act as protective colloids to the deflocculated body.

As I have already stated, I deflocculated clay in the year 1901 and graphite in 1906 and immediately afterward a number of other bodies. I early understood I was producing colloidal conditions of these bodies, but not until the summer of the present year, 1911, did I read any treatise on colloids. During the summer I procured a copy of the book "Colloids and the Ultramicroscope" as written by Dr. Richard Zsigmondy and translated into English by Jerome Alexander of New York. I found the book extremely interesting, and at once wished to have a sample of my deflocculated graphite subjected to ultramicroscopic examination.

Mr. Alexander kindly undertook the examination. He found the graphite in the deflocculated condition to be in a true colloidal state, the particles being in rapid motion, and he estimated their average size in linear dimensions to be 75 millimicrons. Seventy-five millimicrons are seventy-five millionths of a millimeter, and it would require slightly more than 13,000 of the particles to extend one millimeter. Now, the particles of disintegrated graphite, used as the crude material from which to produce deflocculated graphite, pass, as I have stated, through a sieve having 40,000 meshes to the square inch and their maximum linear dimensions is such that it would require 13 of them to extend one millimeter. Hence, the particle of disintegrated graphite is one thousand times greater in linear dimension than the deflocculated one. These are figures that certainly test our powers of appreciation.

When does that process of deflocculation stop? Is it short of the final subdivision and the throwing off of the molecule? I think not. I believe we are here dealing with molecules. Their size may not agree with what they should be as computed in accordance with accepted theories, but, nevertheless, I cannot conceive the subdivision once started, in the presence of sufficient deflocculating agent, will stop short of the final, with the freeing of the molecule and the creation of the colloidal state.

The Engineer's Work in Grading Landscape Areas.

By JOHN N. AMBLER,* M. Am. Soc. C. E.

The problems discussed in this article are most frequently met with in landscape gardening and differ in many respects from those of grading for a railway track or road. In the latter case the narrow width in proportion to the length of the surface to be graded make the problem that of establishing a *grade line* rather than a *grade surface*, which may be either plane and level, plane and inclined, warped, broken or undulating, or combinations of any of these. Hence the problems are intricate ones and are not to be found in any ordinary text-book on surveying.

In practicing landscape engineering the writer has frequently felt the need of some definite and satisfactory method of delineating on paper and executing in the field complicated grading problems where a great variety of surfaces are involved. The subject is one which all surveyors come in contact with to some extent, and is best approached by taking up the simplest case, which is familiar to all, and extending the discussion to the cases presenting more difficulties.

SURVEYS AND MAPS.—As a preliminary to areal grading of any kind an accurate topographical map is a necessity. The survey (except in the case of building sites) should always cover considerably more ground than that to be graded, in order that the slope and form of the surface outside of the grading limits may be taken into consideration. Stadia work is not of sufficient accuracy for earthwork computations which must be made from the map data.

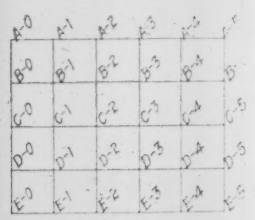


Fig. 1.

The most direct and economical method is to lay off an axis line, preferably through the center of the tract, or as near the center as convenient. On this line hubs, driven flush with the ground, and guard stakes are placed at regular intervals. The hubs, with tack centers, should be set carefully to line by transit, and the line should extend for some distance beyond the limits of grading in each direction, so that it may be reproduced when necessary. Ranges are now run at right angles to the axis line at each hub, and stakes set at intervals apart equal to the distance between the hubs. It is well, also, to extend the ranges some distance beyond the grading limits.

For very close work an interval between stakes of not more than 25 ft. should be used, for this distance is about as great as a string can be employed without an appreciable sag. For ordinary work 50-ft. intervals will answer. Each stake should be plainly marked with its range letter and its number in that range, the first stake being marked 0. Several good substantial benchmarks should be established near at hand, and levels to the nearest tenth of a foot should be taken on the ground at every stake.

The entire survey should be plotted on the largest scale that can be conveniently used. The range lines should be drawn in fine ink lines with the range and number written opposite each station. Contours with a vertical interval of 1 ft. are helpful in all landscape design and in fixing grade elevations in industrial work. An experienced man can put on the contours very rapidly, interpolating their position by eye with sufficient accuracy, while an inexperienced man will require much time to put them in, and will derive a minimum of benefit from them. In many cases, however, they can hardly be dispensed with.

In the discussion following an attempt has been made to classify the character of the grading and to deal with each under a separate heading, beginning with the simplest.

CASE I, GRADE SURFACE PLANE AND LEVEL.—This is nearly always the case when grading for the ground floor or basement of buildings, or any work which is not to be exposed to the weather and requires no provision for drainage. In this case the survey should give elevations on the curb lines, center lines of streets, on door steps and window sills of adjacent buildings, and of any other features relevant to the design. The building is then staked out with corner and offset stakes in a manner familiar to every surveyor.

CASE II, GRADE SURFACE PLANE AND INCLINED.—In this case the inclination may be in one or both directions, and may be for purposes of drainage, as in base-ball grounds, tennis courts, athletic fields, etc., or for factory and warehouse floors and yards for convenience in handling barrels or trucking. Where the slope is in one direction only, the upper and lower edges of the field are given fixed elevations, and parallel range lines are established between them, the grade points on which are easily computed.

When the field is to have a slope both lengthwise and crosswise, the method of establishing the grade at the stations is most easily illustrated by an example. Referring to Fig. 1, suppose we have a rectangular field 500 ft. long and 400 ft. wide sloping on a grade of 1% in each direction.

Taking the grade elevation of A-0 as 110.0 ft., we have:

El. A-1 = 109.0
A-2 = 108.0
A-3 = 107.0
A-4 = 106.0
A-5 = 105.0

In the other direction we have:

El. B-0 = 109.0
C-0 = 108.0
D-0 = 107.0
E-0 = 106.0

Starting from A-1 we have:

El. A-1 = 109.0
B-1 = 108.0
C-1 = 107.0
D-1 = 106.0
E-1 = 105.0

Similarly we may establish a grade elevation for each station.

CASE III, GRADE SURFACE WARPED.—This is a case that would occur in grading for a field or area between buildings where the outer edges on two opposite sides are to be kept level while a drain runs lengthwise through the center line. The floor or field will then be formed of two symmetrical warped surfaces, each shedding water to the center drain, which is in turn on a slope sufficient to drain towards one end.

To illustrate we will assume the same field as before (Fig. 1) with the condition that the edges at the top and bottom of the diagram are to be level and at El. 110.0. The drain is to be located on the center line from east to west. If we assume a grade of 0.5 per cent. and take the elevation of C-0 as 109.0, we may compute the grades at the remaining stations. Following the course of the drain we leave the grades at:

C-1 = 108.5
C-2 = 108.0
C-3 = 107.5
C-4 = 107.0
C-5 = 106.5

The grade at B-1 is found by subtracting from the grade at A-1, which is given as 110.0, one-half the difference between the grades at A-1 and C = 1:110.0 $- \frac{110.0 - 108.5}{2} = 108.25$ = grade of B-1. Similarly the grades at B-2, B-3, B-4, B-5 and at D-1, D-2, D-3, D-4 and D-5 are found.

CASE IV, REGULAR CURVED SURFACES.—Small reservoirs are sometimes constructed with hemispherical or ellipsoidal basins, or with segments of these surfaces. Having fixed upon the dimensions, which in the case of a sphere is the radius, and of an ellipsoid the semi-axes, a, b, and c, it only remains to determine how far the center shall be placed above the rim of the reservoir, and to fix the grade elevation at the lowest point. The origin may be taken as the center of the xy plane, the horizontal reference plane, and the z co-ordinates of points below this plane computed from assumed values of x and y, using the equations $x^2 + y^2 + z^2 = r^2$ for the sphere, and $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ for the ellipsoid. The grade of the point representing the origin being assumed, the grade elevations at the other points are found by subtracting the values of z from it. Such stations may be taken as near together as necessary.

CASE V, TERRACED AND BROKEN SURFACES.—These occur in landscape work on city house lots, gardens, parks, etc., often when the area is not large and many existing conditions must be met and harmonized, as for instance doors, steps, walks, drives and lawns, providing at the same time for adequate drainage. Having noted the floor levels of the various buildings and decided upon the exposure of foundation to be given, it is the practice of the writer to note down on the map the resulting grade elevations at the corners of the buildings.

The terrace lines are then sketched on the drawing and their elevations decided upon tentatively. The sloped surfaces may now be studied in relation to the buildings and the terraces, and as a result the terraces may be modified until a harmonious effect is produced, all guiding elevations being worked out and noted on the plan. As may be readily seen, the successful practice of this method requires considerable judgment and experience.

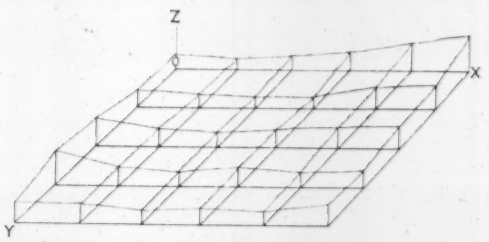


Fig. 2. Isometric Projection of Area to be Graded.

CASE VI, IRREGULAR CURVED, BROKEN AND UNDULATING SURFACES.—These occur in extensive lanscape work as in grading for whole parks, lawns, etc. Surfaces of this kind, if designed along generous flowing lines, where artificiality is eliminated, are productive of very pleasing effects. There are several methods which may be employed for accomplishing grading effects of this kind.

CUT AND TRY METHOD.—Under this method the usual topographical survey and map are first made of the existing ground, and the work of grading is begun without a fully developed design. Excavation is begun at the high points, the excavated material being placed in the low places, thus relieving the greatest inequalities in level. The surface is brought to some kind of uniformity with existing buildings, roads, etc., the entire work being done by eye and the plan developed as the work proceeds. Where the owner is unable to understand plans, or desires to have a hand in the general result, which he can only have by feeling up it, as it were, this method may be recommended.

This method, however, requires more of the time of the supervising engineer than would be the case with a detail plan, and there is constant danger of overdoing the grading at some points and being obliged to restore some places wholly or partially to their original condition. The writer has employed this method with satisfactory results on several occasions, but it cannot be recommended where an advance estimate is necessary, or where economy in engineering service is desired. The larger the area the less likely are satisfactory results to be obtained.

After the grading has been completed, the station markers are reset and new levels taken, from which the amount of excavation is computed and the final estimate by which the contractor is paid determined upon.

"MOLDED CONTOUR" METHOD. — Having prepared a topographical map of the area, the contours are carefully sketched in at a vertical interval of 1 ft. When an engineer has acquired

*Civil and Hydraulic Engineer, Winston-Salem, N. C.

experience in the use of contours he can "mold" an imaginary surface to meet his ideas of what the first surface should be, by shifting about on the map the plotted contour lines. These new contours should be sketched in pencil, as they are likely to be changed many times before their final position is determined upon.

A new tracing should be made giving the section lines and the positions and elevations of all stations. The new contour lines representing the completed grade are inked in on this tracing. As each new contour must begin and end in one of the old contours of the same elevation, the points where these occur should be indicated. The original contours may be shown as dotted lines and the new ones as full lines, or colors may be used. It is now easy to determine the grade at any point by mentally interpolating between the contours. This method is of very wide usefulness, and is probably the most general and flexible of all the methods given, though it lacks some of the accuracy of one of the methods given below.

METHOD OF SECTIONS.—This method involves the preparation of profiles of the ground along each of the longitudinal ranges, and a similar set for the cross ranges. The longitudinal grade lines may then be established on the profiles by means of a flexible, grooved spline, with weights to hold it in any desired position. Having established, tentatively, the grade lines on all the longitudinal sections and marking them on the profile in pencil lines, take from them the grade elevations necessary to plot the graded profile of one of the cross range lines. Testing this profile with the spline will very likely show some incompatible points, which must be adjusted by changing the elevations on one or both of the affected profiles until satisfactory lines can be drawn to take in the points in question.

The same adjustment must be extended to all the profiles of both sets, until the entire surface is properly designed. In comparatively simple cases this method may be abridged by omitting one set of profiles. The other set, say the longitudinal ones, are then plotted consecutively, one below the other, as near together as possible. The eye may then get an impression of the whole surface, and improper cross-sections will be detected. When only one set of profiles is used the ease of comparing adjacent profiles may be increased by plotting the cross-sections on separate strips of profile paper; the profiles may then be compared by placing one over another. The method of sections is much used in connection with the previous method of molded contours.

METHOD OF AXIOMETRIC PROJECTION.—This method consists in assuming a direction on the drawing for longitudinal sections, and another, making an obtuse angle with the first, for the transverse sections. Vertical distances above an assumed datum plane will be plotted on vertical lines on the drawing. A regular isometic projection of the surface has the disadvantage of having the opposite corners of a square plot vertically over each other, thus causing confusion. Hence some other form of axiometric projection is preferable.

For this kind of work it is not necessary to compute the relations between the axes, and to establish the scales for measurement along these axes. An assumed relation and scales are equally effective and far less troublesome to deal with. The writer in his work assumes the longitudinal or x axis horizontal and the transverse or y axis, which is at right angles in the field, is laid off at an angle of from 120° to 150° to the horizontal. The z axis is, of course, vertical.

The datum plane or xy plane is assumed at some convenient elevation, so that with the vertical scale used one section will not overlap the next. The cross-section lines of the original map are reproduced by axiometric projection in lines parallel to the given axes. To avoid confusion each intersection point or station is marked with its range letter and number. On vertical lines erected at each station the elevation of the surface of the ground above the datum plane is scaled off. A line drawn through these points will represent the surface of the ground over this section. Fig. 2 shows the method clearly. After all the longitudinal sections have been thus plotted the profiles of the cross ranges may be sketched on. Both measurements in the horizontal plane xy should be to the same scale, while the vertical scale should be from 2 to 5 times the horizontal scale.

The entire plan should now be inked, the section lines being in black but fine enough to be inconspicuous, while the surface lines should be in brown, making the surface stand out from the rest of the drawing. We now have a reproduction of the ground surface in such shape that a study of grade changes can be made with great ease. Grade lines are established on the longitudinal sections, arranging them by eye so as to have a proper relation between consecutive sections.

The grade lines at right angles may then be tested by means of a spline. The longitudinal grade lines are next adjusted to fit each profile. The final location of the grade lines being established, the elevation at each station is carefully scaled and recorded. This method is best applicable to grading undulating surfaces of large area. It is not well suited to broken or irregular grading such as in terracing and similar work.

EXECUTION OF THE WORK.—In grading for important buildings the most accurate alinement and levels are necessary. Hubs with tack centers should be set at every corner and reference hubs should be set on the prolongation of important lines to reproduce the corners when the corner stakes are removed by excavation. From the cuts marked on the guard stakes the contractor should be able to come within 6 ins. of grade over the floor area, enough earth should be left at each corner to support the hub during the grading work.

If a concrete floor is to be laid, the subgrade should be surfaced very accurately, and it becomes necessary to drive surfacing stakes not over 25 ft. apart in each direction over the entire surface. These stakes should be driven until their heads are accurately 6 ins. above subgrade. Strings stretched across the heads in each direction make it possible to level the surface with great accuracy.

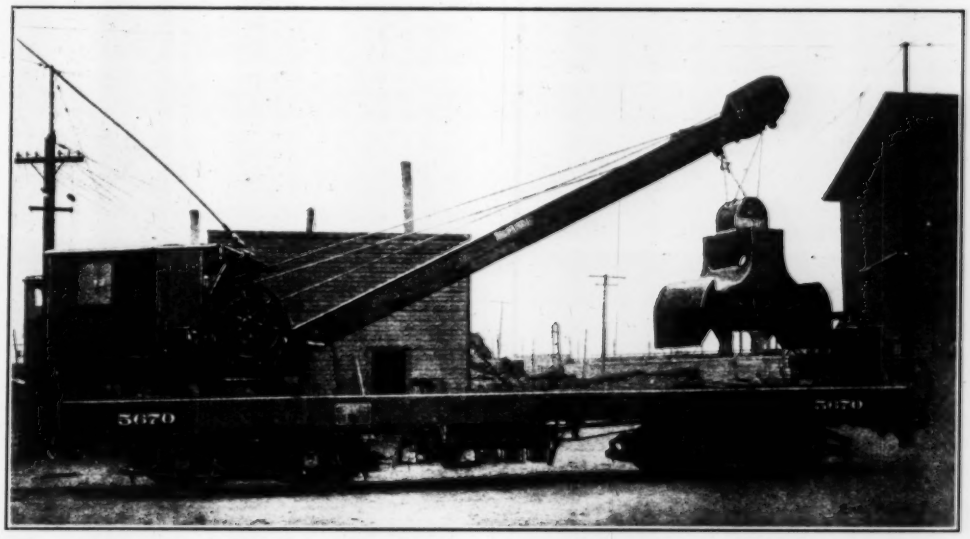
In grading baseball grounds, tennis courts, etc., surface stakes for dressing are also required. The grading and terracing of yards, while requiring precision in some places, particularly with regard to drainage, is best accomplished by staking out a number of prominent points, at which grade elevations may be given. The lines of the terraces should also be indicated and the whole work roughed out on the ground.

The final sloping and adjustment of contours on the ground can best be done by eye, in which process the writer frequently makes minor improvements over his original plans. Staking out work of this character in detail would be very difficult of execution.

In grading areas other than those mentioned, such as lawns, parks, cemeteries, athletic fields, etc., it is well to require the contractor to leave a mound of undisturbed earth 2×2 ft. at each stake where excavation is made, and where embankment is to be made to erect stout poles with the heads set to grade. In this way the contractor has reference points to test his grade at any time. The mounds around the stakes should be removed last and any irregularities in the surface intermediate may then be corrected. Surface stakes are not necessary in this class of work, as an experienced eye can detect irregularities with astonishing quickness.

Electric-Crane Cars for the Public Service Railway, Newark, N. J.

Two work-car cranes of interesting design, shown in the accompanying figures, have recently been furnished the Public Service Railway, of Newark, N. J., for the use of its Way Department, the company now operating three of this type. The first car was used only for lifting work and delivering heavy materials. Larger possibilities of service appeared, and the two new cars have been equipped for use of 22 cu. ft. double-rope grab buckets, so that dirt thrown out from the track excavation to the sides of streets may be loaded into the cars by the crane instead of by hand shoveling, as formerly. It is expected that such use of the crane cars in loading work-cars on the street, in construction and reconstruction of track, will show a large saving in cost of labor. It is reported that at least $50 a day has been saved over manual labor by using one of the crane-cars for moving heavy timbers in the construction and repair of trestles.



ELECTRIC-CRANE WORK CAR OF THE PUBLIC SERVICE RY., NEWARK, N. J.
(Built by the Brown Hoisting Machinery Co.)

One interesting and unusual service was found for this apparatus last summer when a runaway horse went on a private right-of-way and got stuck in a trestle, with all four legs down between the ties and decking. A police officer was about to shoot the horse when one of the track-walkers called for a crane-car. This was immediately dispatched, and the horse was raised in slings onto the car, which was then run out to the surface tracks and the horse released, unhurt. The line was tied up about 25 minutes by this accident, whereas without the use of the crane-car, it would have taken fully an hour to clear the track.

The side sills of the car body consist of 12-in. 30-lb. channels, bent over at the ends and spliced. On the top of each sill there is riveted a 5 × 3 × ½-in. angle iron upon which the flooring is laid. The flooring is of 2-in. oak, with 1-in. boards on top. There are 3/16-in. steel plates, 8 ins. wide, on each side of the body for the full length of the car. There are also ⅛-in. steel cross strips, 2 ins. wide, 12 ins. c. to c., along the full length of the floor. On each side of the car is a 1⅛-in. truss rod, with two Queen posts. Pockets are cut in the floor along each side of the car to allow

for placing braces to support material on the car. The boom heel and crane bed have been sufficiently elevated so that the crane can be revolved when the car is loaded along the side with rails. A wood insulating head has been placed on the end of the boom to prevent danger of careless contact with the overhead wire, although ordinarily in unloading the boom is not raised as high as the trolley wire.

The car shown in the accompanying cut has a maximum lifting capacity of 10,000 lbs. at a radius of 11 ft. At the maximum radius of 20 ft. 6 ins., the lifting capacity is 5,000 lbs.

These cranes were furnished by the Brown Hoisting Machinery Co., of Cleveland, Ohio. For the information here presented, we are indebted to that company and to Mr. Martin Schreiber, Engineer of Maintenance of Way, Public Service Ry., Newark, N. J.

Damages to Roads and Pavements caused by openings to lay or gain access to pipes and wires are by no means confined to the United States, judging from the following remarks by Mr. H. Frost, Surveyor to the Gosport Urban District Council, England, as reported in the "Journal" of that town:

The greatest evil in connection with the more permanent forms of paving in an urban area is the continual breaking up of surfaces by telephone, electric lighting, gas and water companies, and plumbers and others having the power to do this; and the difficulties of getting an efficient and permanent reinstatement of the surface; and it is not be expected—even if well reinstated—that material can consolidate to the same solidity as obtains when it may have undergone compression for generations, as in the case of the older and ordinary thoroughfares.

Tests of Large Boilers at Detroit*

By D. S. JACOBUS,† M. Am. Soc. M. E.

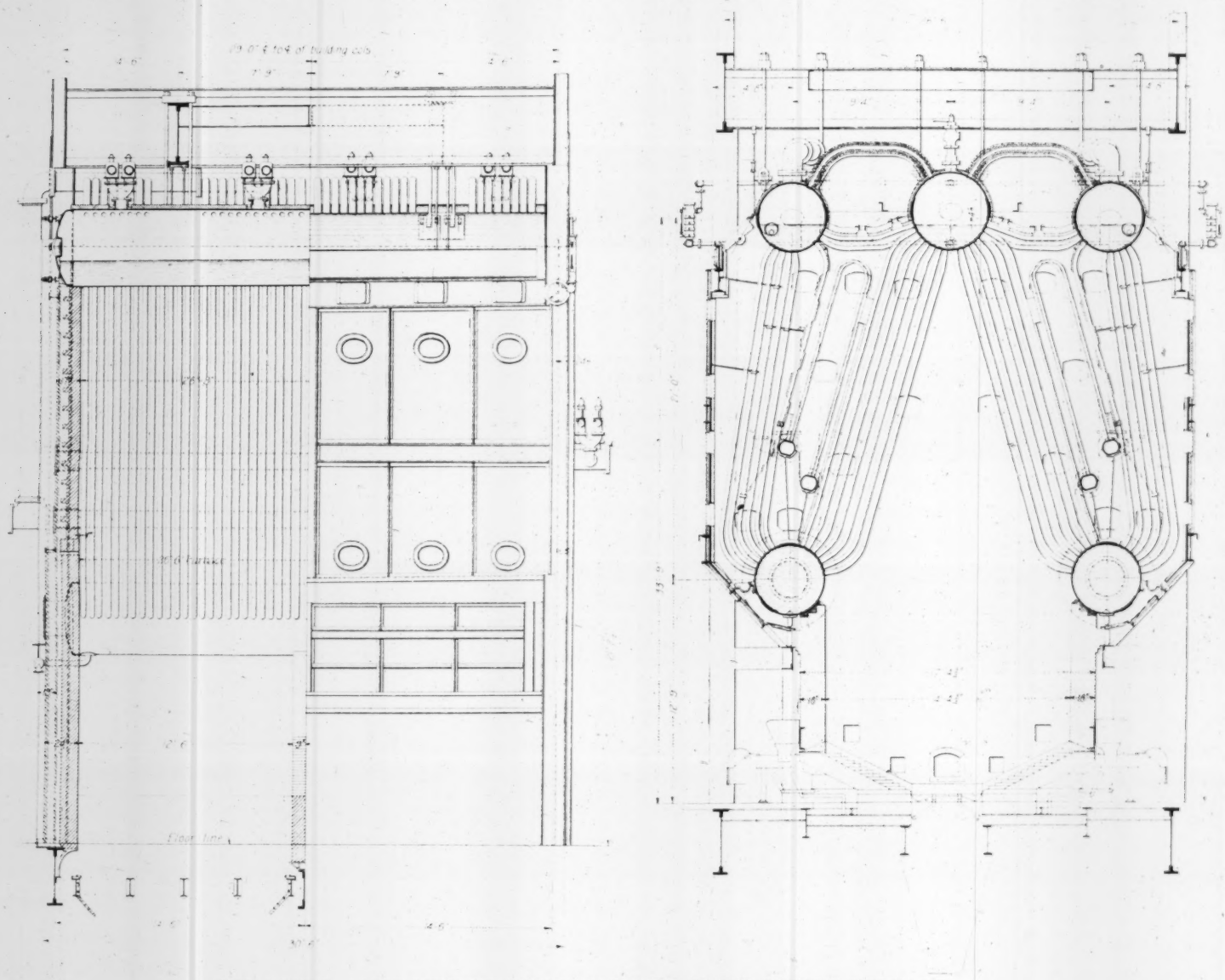
THE DETROIT INSTALLATION.—Many have held that eventually much larger steam boilers will be used than those in service. The size of turbo-electric generating sets has increased by rapid strides and it might seem that an increase in the size of boilers would naturally follow. There has been a strong feeling, however, that it would be unwise to employ very large boiler units, as a failure of one of the large units would throw out of use a much greater proportion of power than the failure of a smaller unit. The engineering world is greatly indebted to the Detroit Edison Co. and to Mr. Alex. Dow, General Manager, for pioneer work in installing boilers of two or three times the capacity of the largest boilers heretofore used, and for the opportunity of conducting the most elaborate and painstaking series of tests ever made on a boiler.

Each of the boilers described in this paper is required, in the all-day practice of the power plant, to carry a load of 6,000 KW. and in the evening to carry 7,000 or 8,000 KW. The experience in regular service of 18 months with the first boiler and of nine months with the second and third boilers has proven this to be good practice. The rated capacity of each boiler is 2,365 HP. on the basis of 10 sq. ft. of boiler heating surface per horsepower. Fourth and fifth boilers are now being erected and it is expected to complete the installation of ten boilers of this size within the next two years.

Two series of tests were made, one on a boiler fitted with Roney stokers, the other on a boiler fitted with Taylor stokers. Four Roney stokers were used in the furnace, two being at the front and two at the rear of the boiler. There was a low division wall between the stokers, and between the two sets of stokers a bridge wall. The Taylor stokers had 13 retorts on the front side and 13 on the rear, or 26 in all. The retorts on each side were set in a continuous row so as to provide an unbroken fire surface from one side of the boiler to the other. There was no bridge wall between the Taylor stokers, and when the dumping plates at the rear of each were covered with fuel there was a continuous fuel bed beneath the entire boiler. The width of the furnace from one side to the other of the boiler was about 26½ ft., and the depth of the furnace from the front to the rear of the boiler about 14 ft. The height of the furnace, measured above the dumping grates to the top of the first baffle, was about 29 ft. The large furnace volume combined with the particular form and height of the furnace had much to do with obtaining the high efficiencies.

In the development of the large units at Detroit, Mr. Dow expected an increase in economy due to minimizing the radiation losses, and to the high temperature obtainable in the large furnaces and combustion chamber. He also expected a reduction in the first cost, not on account of a reduced cost per unit of boiler surface, but to a less cost of the settings, floor space, suspension structures, valves and piping. Troubles through brickwork were anticipated and there were troubles which, in the main, have been overcome.

Another most important feature that had to be considered with so large a boiler unit was the possibility of tube troubles. In dealing with this point Mr. Dow inferred that their experience at the plant with the feed water used in connection with boilers of a similar general type, warranted the conclusion that they should have practically no trouble with the tubes. This has been borne



FIGS. 1 AND 2. LARGE STERLING BOILERS INSTALLED BY THE DETROIT EDISON CO.
(Rated capacity 2,365 HP.)

*From a paper to be presented at the annual meeting of the American Society of Mechanical Engineers, New York City, Dec. 5-8, 1911. Printed in the November issue of the Journal of the Society.

†Advisory Engineer, Babcock & Wilcox Co., 85 Liberty St., New York City.

out by the experience with the boilers in actual service.

Mr. Dow credits his friend, Mr. W. H. Patchell, for the first idea of the possibilities of large boilers. The boilers and settings at Detroit have no similarity to those installed by Mr. Patchell, but Mr. Dow says that to him is due the first conception of the economical possibilities of the large units and the capacity obtainable through utilizing the whole floor area for the furnace.

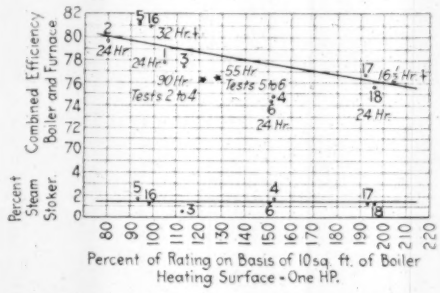

Combined Efficiency Boiler and Furnace.
Percent Steam Stoker.
Percent of Rating on Basis of 10 sq. ft. of Boiler Heating Surface = One HP.

Fig. 3. Results of Tests on Boiler With Roney Stoker.

(†Milburn Coal Used for Tests No. 16 and 17; Red Jacket Used in all Others.)

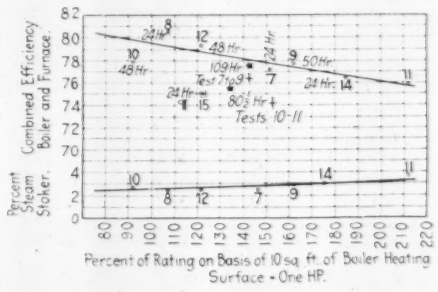

Combined Efficiency Boiler and Furnace.
Percent Steam Stoker.
Percent of Rating on Basis of 10 sq. ft. of Boiler Heating Surface = One HP.

Fig. 4. Results of Tests on Boiler With Taylor Stoker.

(†Including periods between tests; ¶Including banking period of 7½ hours.)

FIGS. 3 AND 4. RESULTS OF DETROIT BOILER TESTS.

The boilers were built by the Babcock & Wilcox Co. Each contained 23,654 sq. ft. of effective boiler heating surface and was provided with superheaters for supplying approximately 150° of superheat. The grate surface, measured from the beginning to the rear of the dumping grates was 446 sq. ft. for the Roney stokers and 405 sq. ft. for the Taylor stokers. This method of measurement is not that usually employed in determining the grate surface of an underfeed stoker, but it was used in order to obtain comparative figures for the two stokers.

The design and installation of the plant and the general arrangement of the boilers and piping were under the charge of Westinghouse, Church, Kerr & Co. This firm designed the arrangement of the furnace brickwork for both the Taylor and Roney stokers; supervised the construction and followed up and corrected the minor defects which developed. This work and the general arrangement of the apparatus for the tests was under the charge of Mr. H. O. Pond, to whom the author is indebted for valuable assistance.

TESTS OF THE DETROIT INSTALLATION.—The preliminary and regular tests required that the boiler room of a large power house be under the control of the observers for nearly three months, and for six weeks over 50 men worked in 8-hr. shifts, night and day, exclusively on the tests. All the water and coal was accurately weighed and much work was done about the plant to avoid the possibility of leakage affecting the results. The magnitude of the undertaking may be appreciated when attention is drawn to the total quantities measured, which were as high as an average per hour of eight tons of coal, 75 tons of feed water and one ton of ashes, the totals amounting to about 5,000 tons of coal weighed and 45,000 tons of water.

The tests were run under the direct supervision of the writer, assisted by men chosen from the engineering staff of The Babcock & Wilcox Co. In addition to the men furnished by the Detroit Edison Co., the Solvay Process Co. provided a number of observers. Their experimental engineer, Mr. Lewis C. Rogers, cooperated in securing the results and rendered most valuable assistance. Westinghouse, Church, Kerr & Co. cooperated in designing apparatus and in making arrangements for the tests and was represented in the tests. The Solvay Process Co. made heat determinations and analyses of the coal used in each test, and of the ashes. Duplicate samples were taken and the work was done a second time in the laboratory of the Babcock & Wilcox Co. The average of the results secured by the two laboratories was used in working up the tests.

The tests reported in this paper were made after a painstaking series of preliminary tests with both of the stokers, and the operators were well trained in maintaining uniform conditions. Twenty-four hours is none too long an interval for obtaining accurate results with an underfeed stoker of the class tested, as one can readily appreciate when the fact is called to his attention that the generation of steam will continue after no more coal is fed to the furnace with but little difference in the appearance of the fire. There is no method whereby the fire can be measured except by sizing it up by the eye, as one must form an estimate of the amount of clinker present. One of the operators at the plant was earnest in his opinion that the fires as balanced up by the author for the Taylor stoker contained from 2½ to 5 tons more coal at the end of a test than at the beginning, a contention that was shown beyond doubt to be in error by the heat balances. This goes to snow how far the estimates of the amount of coal may affect the results that consequently there is great danger of obtaining erroneous figures in short tests.

It was proposed at first to run a test of a week or more on each of the stokers, but this plan was abandoned, since there was trouble through leakage in the feed pump which made it necessary to shut down, and on reconsidering the matter it was deemed advisable to give up running as long a test as this since it developed that a week would be too long a period to run without blowing down the boilers.

Preliminary tests were first made on the boiler with the Taylor stoker. The apparatus was then shifted and preliminary tests were made on the boiler with the Roney stoker. A careful study of the operating conditions for the best economy was made in the preliminary tests. The results of the regular tests only are given in this paper.

Great care was taken to prevent the possibility of leakage affecting the tests. All fittings where there might be leakage were either blanked off or two valves were provided with an open drip between them. The boilers were tested with hydraulic pressure both before and after the tests. Special leakage tests were also made in which the hot boilers were completely filled with water and the full pressure maintained on the boilers and feed mains, and in each case were was no leakage indicated in tests of several hours' duration.

Water from the heater was elevated by means of a centrifugal pump specificially provided for the purpose and discharged into tanks supported on special platform scales. The men weighing the water were protected from the weather by a rough housing placed above the level of the tanks, the scale beams being inside this housing. The water from the tanks ran into two lower horizontal tanks. The lower tanks were provided with gage glasses and the water was brought to an accurate level every hour. The water from the lower tanks was pumped directly into the boilers by one of the regular centrifugal feed pumps used at the plant. Any leakage in the glands of the pump was caught and returned to the large horizontal tanks by a small centrifugal pump. A special condenser and weighing apparatus was erected for determining the amount of steam used by the stoker auxiliaries. All scales were accurately calibrated to their full capacity before and after the tests of each of the boilers by means of standard weights.

Saturated steam from another boiler was used for driving the auxiliaries. The saturated steam was reduced to its equivalent weight of superheated steam in determining the percentages given.

The tanks for weighing the water had each a capacity of 20,000 lbs. Three such tanks and scales were provided, two being used regularly and the third held for a spare in case any irregularity developed in either of the other two. The coal was weighed by means of four special scales carrying overhead hoppers, each of about 2,500 lbs. capacity. The coal was conducted from the regular chutes into the hoppers, which were provided with hinged bottoms held in place by latches.

Readings of temperatures, pressures, etc., were taken every half hour. The water was balanced each hour. The coal weighed per hour and supplied to the hoppers was balanced each hour and recorded, but no attempt was made to obtain a correct coal balance except at the beginning and ending of the tests, as this necessitated running the coal quite low in the hoppers of the stokers. As soon as the data was taken, a copy was made on a large sheet in the boiler room, so that those conducting the tests could, at a glance, note whether the conditions were uniform. Marks and Davis steam tables were used in working up the results.

The analyses of the gases after leaving the boiler dampers were made with an Orsat apparatus, the samples of gas being obtained from the middle points of the flues.

RESULTS OF THE TESTS.—A resume of the results obtained is given in the accompanying table. Figs. 3 and 4 show the results of these tests graphically.

It will be seen on examining the tables and figures that the combined efficiency of the boiler and furnace varies from about 80% at slightly below rating, to about 76% at double rating. In obtaining these efficiencies, the steam used for driving the stokers and for producing the forced blast for the Taylor stokers has not been deducted from the total steam generated by the boiler. The amount of steam used by the Roney stokers was about 1½% of the total steam generated by the boiler, and for the Taylor stokers about 2½ to 3%. The effect that this steam would have on the plant economy depends on the ability to utilize the same for heating the feed water. In a plant where the heat in the steam exhausted from the auxiliaries is returned to the feed water there would be but little loss. In the case of the Taylor stokers all of the exhaust steam from the turbines driving the forced-blast fans may be carried to the feedwater heater, whereas with the Roney stokers only, about 1/5 of 1% of the 1½% used may be so returned, since the greater part of the steam is used in the jets which supply steam beneath the ignition arches of the stokers, and passes away with the chimney products. In a plant in which the auxiliaries are electrically driven, any power to operate the forced-blast apparatus would be a direct loss and, assuming in the case of the Taylor stoker that the steam consumption corresponding to the current required to drive the electrical auxiliaries is one-half of that found in the tests, the steam required to operate each of the stokers would be about the same. It therefore follows that the effect of the steam for

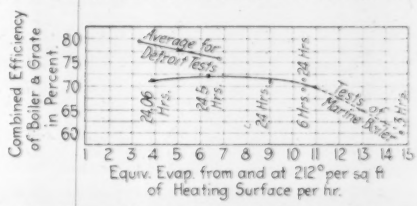

Combined Efficiency of Boiler & Grate in Percent.
Average for Detroit Tests.
24.06 Hrs.
24.5 Hrs.
24 Hrs.
Tests of Marine Boiler.
Equiv. Evap. from and at 212° per sq. ft. of Heating Surface per hr.

Fig. 5. Comparison of Detroit Tests With Tests of a Marine Water-Tube Boiler.

driving the stokers on the station economy cannot be generalized, but that each plant must be considered by itself.

The efficiencies secured are exceptionally high, and the question may be asked whether this is due entirely to the large size of the boiler units. A careful study of the test data shows that the efficiencies were obtained with the most economical furnace conditions and that the thoroughness with which the fuel was consumed in the furnace had much to do with the attainment of the high figures. On examining Figs. 1 and 2, showing the general arrangement of the boilers and settings, it will be seen that the roof of the furnace has an A shape, and that the coal is fired at the front and rear of the boiler setting. With this arrangement, the character of the combustion may be maintained constant from one side of the boiler to the other, and the loss so often experienced through a stream or lane of excess air or unconsumed combustible gases passing through the boiler and escaping to the stacks will be avoided. Those conversant with the subject know that in ordinary boiler furnaces there is a great variation in analyses taken from different points in the path of the flue gases leaving the furnace, whereas with the present furnace arrangement this action is reduced to a minimum, as any irregularity from the front to the rear of the grates disappears before the gases pass from the upper part of the combustion chamber, and as the composition of the gases for uniform firing conditions will be uniform from one side of the boiler to the other, or from right to left in Fig. 1, it follows that the composition of the entire volume of the gases leaving the furnace will be substantially uniform.

A straight reference line is drawn in Figs. 3 and 4 in order that the results obtained by the two stokers may be readily compared, this line

being the same on both diagrams. It will be noted that the test results fall on both sides of the line, and that the efficiency obtainable with each stoker is about the same. Naturally a curve should be used instead of a straight line to show the variation in the efficiency, but the accidental variation in the test results is such that it would be impossible to trace an exact curve.

On examining Fig. 3, it will be seen that the efficiencies, where several tests are worked out together, including the periods between the tests, are only about 1½% lower than would be indicated by averaging the results for the separate tests by passing a straight line between the points. The same follows for the tests which are worked up together for the Taylor stoker. This shows that including the periods between the tests, during which the dust was blown from the exterior of the tubes and the firing was not watched as carefully as it was during the tests, did not greatly lower the efficiency.

Test No. 15, with the Taylor stoker, included a banking period of 7½ hrs. It will be noted that the efficiency, including the banking period, is about 75%.

The minimum length of a regular test was 24 hrs. The efficiency for a test of 16½ hrs. is plotted in one diagram. In this particular test a special coal was used which ran out and thus brought the test to a close. Some of the tests were of 48 hours' duration and over.

The average analyses of the flue gases show that the furnace efficiency was exceptionally high for both of the stokers.

The results of the heat balances show that the average radiation and unaccounted-for losses are only about 2½ to 3%. There is naturally a variation one way or the other due to accidental errors, but the results are as uniform as could be expected in work of the sort.

In order to compare the results with others where high efficiencies have been secured, Fig. 5 is presented. In this figure the straight line shown in Figs. 3 and 4 is transferred and marked, "Average for Tests of Detroit Boiler." The plotted results for individual tests shown in Fig. 5, are for tests made by a Board of U. S. Navy on a hand-fired Babcock & Wilcox marine boiler and reported in the Journal of the American Society of Naval Engineers, November, 1910. By combining the results secured with the two boilers it will be seen that the efficiency varies from about 80% at an evaporation of 3 lbs. per sq. ft. of heating surface per hour from and at 212° F. to 76% at 7 lbs., 72% at 10 lbs. and 60% at 14.7 lbs. It therefore follows that if the performance of the two boilers could be combined, a boiler could be run from about 80% of the ordinary rating to over four times this rating, and for most classes of central power-plant service it would be possible to run all of the boilers in the plant all of the time, thus eliminating the loss occasioned through having to carry a number of boilers under banked fires. The writer is now working on the development of a boiler of this sort.

TABLE I.—GENERAL DATA AND RESULTS OF TESTS OF LARGE BOILERS OF DETROIT EDISON CO.
WITH RONEY STOKER.

No. of Test.	Length, hr.	Per cent. rating.	B.t.u. in coal.	Per cent. ash in dry coal.	Effi-ciency.	Per cent. steam used by stoker engines and steam jets.	Per cent. Com-bustible in ash.	Fahr. temp. flue gases leaving boiler.	Analysis of Gases In Flue. CO_2.	O.	CO.
1	25	105.0	14,362	5.98	77.84	...	19.6	576°	11.95	7.55	0.05
2	24	80.0	14,225	6.52	79.88	...	17.9	480°	14.33	4.54	0.11
3	24	113.8	14,308	7.40	77.45	0.63	24.4	542°	13.05	6.46	0.18
4	30	152.4	13,756	6.54	75.78	1.58	30.8	670°	14.74	3.96	0.54
5	24	94.0	13,896	6.89	81.15	1.75	31.6	483°	14.40	4.54	0.35
6	24	150.7	14,037	6.13	75.28	1.45	26.7	662°	14.66	4.23	0.31
16	32	98.6	14,476	9.68	80.98	1.34	34.1	460°	13.55	5.92	0.07
17	16.5	193.3	14,493	8.24	76.73	1.39	24.6	636°	14.69	4.55	0.20
18	24	195.7	13,689	9.81	75.57	1.32	23.2	694°	14.16	5.04	0.16
2-4[1]	90	119.8	14,098	6.81	86.13	...	25.8	572°	....	...	...
5-6[1]	55	127.3	13,977	6.84	76.23	...	29.4	575°	....	...	...
WITH TAYLOR STOKER.											
7	24	151.2	14,000	7.03	77.07	2.61[2]	31.5	575°	14.00	5.50	0.42
8	24	107.9	13,965	6.34	80.28	2.44[2]	27.1	493°	13.69	5.82	0.10
9	50	162.8	13,998	6.75	77.85	2.87[2]	31.3	574°	14.74	4.57	0.12
10	48	92.9	14,188	9.90	77.90	2.63[2]	27.2	487°	11.86	7.96	0.06
11	26.5	211.3	14,061	9.55	75.84	3.41[2]	36.1	651°	15.45	3.86	0.17
12	48	121.3	14,010	8.09	79.24	2.57[2]	27.6	535°	13.79	5.73	0.04
14	24	185.2	14,272	8.71	76.42	2.95[2]	28.8	647°	14.20	5.08	0.08
15[3]	24	123.1	14,213	8.34	74.90	2.77[2]	30.1	561°	10.83	8.93	0.09
7-9[4]	109	140.0	13,983	7.22	77.66	2.68[2]	29.9	545°	....	...	...
10-11[4]	80.5	132.8	14,095	9.58	75.66	3.04[2]	31.1	542°	....	...	...

[1]Including periods between tests.
[2]Engines driving stokers and steam turbine driving fans; no jets.
[3]In test No. 15 the fires were banked for 7½ hrs. and the averages include this period.
[4]Including periods between tests.

TABLE II.—HEAT BALANCES, DETROIT BOILER TESTS.
FLUE GAS ANALYSES AND TEMPERATURE TAKEN IN BREECHING.
WITH RONEY STOKER.

Test No.	Absorbed by boiler.	Moisture in coal.	Hydrogen in coal.	Heat to Chimney: Heat to chimney.	Moisture in air.	Total.	CO.	Carbon in ash.	Radiation, etc.
1	77.84	0.18	4.55	13.56	0.37	13.93	0.23	1.20	2.07
2	79.88	0.16	4.36	9.15	0.26	9.41	0.42	1.20	4.57
3	77.45	0.15	4.48	11.39	0.32	11.71	0.74	1.85	3.62
4	75.78	0.17	4.49	12.79	0.36	13.15	1.95	2.13	2.33
5	81.15	0.16	4.29	9.11	0.20	9.31	1.29	2.29	1.51
6	75.28	0.21	4.74	13.17	0.36	13.53	1.16	1.71	3.37
16	80.98	0.22	4.18	8.94	0.19	9.13	0.27	3.20	2.02
17	76.73	0.22	4.47	12.47	0.28	12.75	0.74	2.05	3.04
18	75.57	0.21	4.64	14.34	0.27	14.61	0.62	2.42	1.93
								Average	2.72
WITH TAYLOR STOKER.									
7	77.07	0.18	4.58	11.54	0.28	11.82	1.61	2.31	2.43
8	80.28	0.17	4.28	10.12	0.24	10.36	0.40	1.80	2.71
9	77.85	0.20	4.31	11.21	0.25	11.46	0.44	2.20	3.54
10	77.90	0.18	4.34	11.35	0.26	11.61	0.27	2.77	2.93
11	75.84	0.18	4.47	11.91	0.35	12.26	0.59	3.58	3.08
12	79.24	0.18	4.46	11.05	0.21	11.26	0.16	2.32	2.38
14	76.42	0.18	4.51	13.15	0.27	13.42	0.31	2.57	2.59
								Average	2.81

A Recording Voltmeter, Ammeter and Pyrometer of Accuracy and Great Sensitiveness.*

In Engineering News, Jan. 2, 1908, a much needed recording electrical milli-voltmeter of accuracy and extreme sensitiveness was described as designed by Mr. Wm. H. Bristol. It will be recalled that the pointer of the moving system carried a sharp stylus instead of the usual pen and that a clockwork tapper caused this momentarily to touch a lightly smoked chart.

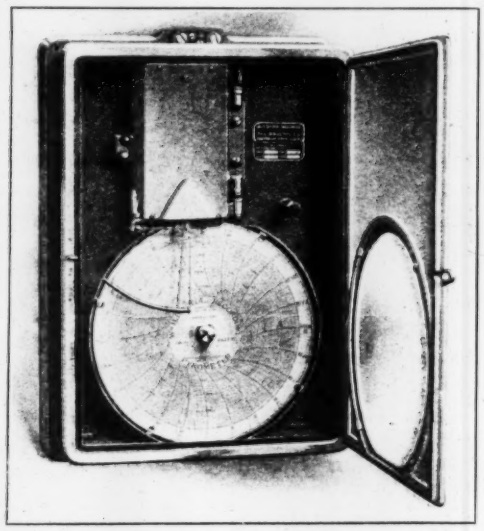


Fig. 1. Electrical System and Tapping Mechanism Locked in Place Over Chart.

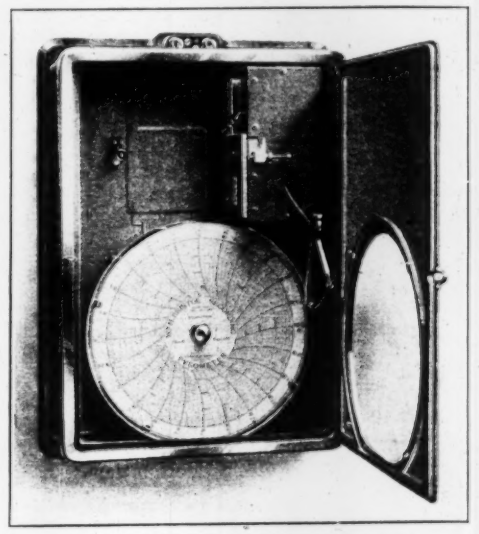


Fig. 2. Moving Systems Moved Clear of Chart.

FIGS. 1 AND 2. THE BRISTOL INK-CHART RECORDING MILLI-VOLTMETER (PYROMETER FORM).

In this way two errors were eliminated; (1) that due to the friction of dragging the pen across a paper chart, and (2) the unbalance of the pen arm and impaired calibration due to varying the amount of ink carried on the pen. These smoked charts were made permanent by dipping in a thin gum solution like artist's fixative The instrument was particularly adapted for use as a recording shunt ammeter, reading milli-volts drop across a standard resistance, and as a pyrometer when used with a thermocouple.

While the smoked charts were generally found entirely satisfactory, yet there were many who objected to the use of a new type of chart alongside the older inked records, not being willing to add the slight complication. Therefore work was continued on the development of an ink-chart instrument which should embody the advantages of the smoked-chart type without the two sources of error noted.

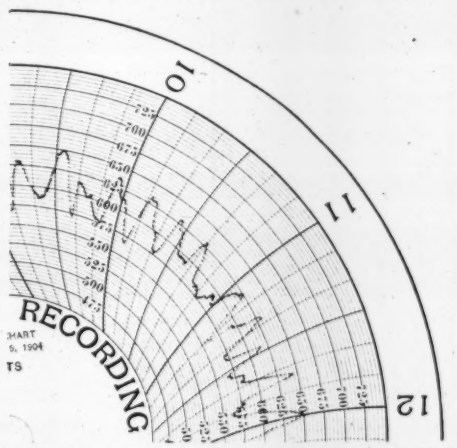


Fig. 3. Section of Ink-Chart Record; Bristol Milli-Voltmeter (Pyrometer Form).

The tapping clockwork has been retained, but the stylus is replaced with a gold capillary tube extending from the end of the pen arm toward

*From information furnished by Mr. William H. Bristol, M. Am. Soc. M. E., The Bristol Co., Waterbury, Conn.

the chart and also in the other direction toward the tapper frame, as seen in Figs. 1 and 2. The tapper carries a linen ink pad enclosed in a slotted tube and moves against the pen to force the pen against the chart momentarily. Whatever ink is transferred to the chart is replaced from the pad, the capillary tube always carrying a constant amount.

The electrical system and the clockwork tapper are contained in a metal box carried by the main case on heavy trunnions and can be swung out when an old chart is to be replaced. This inner case locks accurately in place with the pen over the chart.

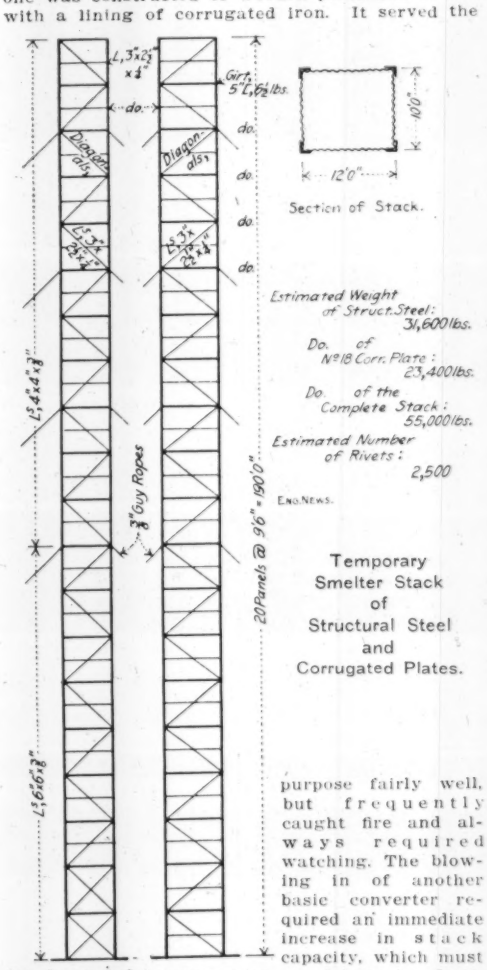
Where the movement of the pointer is large the record is a series of dots as shown in Fig. 3. Where the movement is small the dots merge into a line.

A Structural and Corrugated Steel Stack.*

By PERCY ELMER BARBOUR,† M. Am. Inst. M.E.

The following brief description of a temporary stack gives an interesting example of unusual practice. I have never heard of any other stack of this size built of corrugated plates and structural steel.

At the Garfield Smelter, Garfield, Utah, an additional stack was required in short order, and one was constructed of wooden posts and braces with a lining of corrugated iron. It served the purpose fairly well, but frequently caught fire and always required watching. The blowing in of another basic converter required an immediate increase in stack capacity, which must be cheap and temporary, as an elaborate and expensive flue and stack system for all the converter gases was being designed.



Temporary Smelter Stack of Structural Steel and Corrugated Plates.

This stack, designed and built by the writer, was 10 × 12 ft. inside, 190 ft. high, and rested on the steel work of the old structure, which was 20 ft. 6 ins. high, thus making the top of the stack 210 ft. 6 ins. from the ground. The corner members of the structure were of 6 × 6 × ⅜-in. angles for the lower nine panels and of 4 × 4 × ⅜-in. angles for the remaining upper eleven panels. Each panel was 9 ft. 6 ins. high. The girts were of 5-in. 6½-lb. channels, and the diagonal ties were 3 × 2½ × ¼-in. angles with the long leg outstanding. The panels were made 9 ft. 6 ins. in order to take a 10-ft. sheet of corrugated metal, and, because this was too long an unsupported span, a 3 × 2½ × ¼-in. angle girt was put in the middle of each panel. At the base of the structure a 6 × 6 × ⅜-in. angle was used on all four sides to connect the stack to the old steel work. At all panel points ⅜-in. gusset plates were used.

The corrugated plates were bolted on with ⅜-in. bolts through the channel girts and held on the inside by means of straps of ¼ × 1¼-in. iron, and were fastened to the angle iron girts by means of 9-in. clinch nails.

The steel erection gang consisted of five men, including the boss who operated the air hoists with which the hoisting was done. Three of the men were topmen. The riveting gang consisted of four men and a gang of four men put on the corrugated plates.

After the skeleton was erected and riveted, it was painted, two men doing this in one and one-half shifts of eight hours, with two men below to lower staging which was inside the skeleton and slung from a single block at the top. The corrugated plates were painted on the ground before they were put in place.

The total estimated weight of the stack was 55,000 lbs. The total cost of the stack completed was $4,887.62. This cost in detail is as follows:

			Cts. per lb.
LABOR:			
Erection contract*	$650.00		
Erection gang, extra labor	106.90		
Total erection		$756.90	1.376
Machine and boiler shops	$659.30		
Carpenter shop	69.45		
Mason	1.45		
Common labor	40.00		
Hauling	6.35		
Total fabrication and outside		776.55	1.412
MATERIALS:			
Structural steel	$804.44		
Corrugated iron	768.00		
Round iron and steel plate	487.22		
Rivets, bolts, and clinch nails	175.86		
Total structural		2,235.52	4.064
Cast iron	$6.94		
Guy wire	265.29		
Paint	105.14		
Cement	15.00		
Lumber	7.63		
Tools and sundries	8.92		
Total sundries		408.92	0.744
Supervision, city office		709.73	1.290
Total cost of stack completed		$4,887.62	8.886

*The actual cost to the contractor for erection was $708.23, but the extra work due to a multiplicity of shop errors in fabrication more than offset the contractor's loss, which is therefore not taken account of in the per pound cost.

Of course this is a high cost per pound, but the structure is a skeleton, the shop was unused to fabricating work of this kind, and the erection was done under great difficulty, as the sulphur smoke was at times heavy enough to drive the men to the ground. My original estimate of the cost was 10 cts. per pound.

*Reprinted from the "Journal of the Worcester Polytechnic Institute" for November, 1911.

†Superintendent Uwarra Mine Co., Candor, N. C.

Flood Prevention Works in the Province of Silesia in Germany; The Maurer Dam.*

The river valleys in the western part of the Province of Silesia, in Germany, have long suffered from periodical floods, and it is not until recently that effective measures have been taken to moderate their destructiveness. So long as the case was left in the hands of the local authorities, little was accomplished, although each recurring flood did greater damage than the previous one, owing to the increased development of the Province. As the Province of Silesia could not well bear the whole cost of the necessary flood prevention works, the Prussian State came to the assistance and is bearing four-fifths of the expense. The Province, however, is to maintain the works. These works were begun in 1900, and are now nearing completion.

The Province of Silesia is drained almost entirely by the River Oder, which runs across it in a northwesterly direction. The tributaries on the right bank flow through a flat, sandy district, and are comparatively unimportant; but the tributaries on the left drain a fertile hilly country between the Sudetic Mountains and the River Oder. These valleys have suffered from 42 serious floods since 1567; in the last century these were 15, or one on an average of every 8 years. The situation was aggravated by the fact that nearly all these floods took place in the late summer, when the harvests were ready for reaping.

The annual rainfall in the mountains is about 55 ins., but in the summer time extraordinarily heavy thunderstorms take place, in which 8 ins. of rain will sometimes fall in 24 hours. An exceptionally destructive flood, caused by a cloudburst in the mountains, did widespread damage in July and August, 1897. At Sagan, where the River Oder has a drainage area of 1,048,000 acres, the flow for some days previous to the flood was about 880 cu. ft. per sec. On July 29, 1897, the flow increased from this amount to 14,110 cu. ft. per sec., which was all the channel could carry in about 24 hours. On the afternoon of July 31, the discharge was maximum at 70,550 cu. ft. per sec. Taking the drainage area as 1,640 sq. mi., this is a normal dry-weather flow of 0.54 cu. ft. per sec. per sq. mi., a safe flow of 8.6 cu. ft., and a maximum flow of 46.0 cu. ft. At the head of the River Queis the maximum intensity of flood discharge was 358 cu. ft. per sec. per sq. mi. from a watershed of 7,900 acres, which is equivalent to a run-off of nearly 0.6-in. per hr.

In determining the cost of measures for protection on each stream, more attention was given to the value of the property to be protected than to the mean discharge or length of the stream. The principal works are in connection with the Rivers Oder and Queis. The conditions on these two rivers were unfavorable to large reservoirs in the mountains, near the headwaters, so a series of comparatively small reservoirs were placed above the principal towns on the head streams, and a large reservoir was placed below at a favorable site on the main stream, which would protect the whole valley below. Thus, on the headwaters of the Oder, there have been constructed five reservoirs, with capacities ranging from 210 to 1,580 million gals. (U. S.), while on the main stream above the village of Maurer a reservoir, holding 13,200 million gals., is being constructed.

This reservoir is made by a masonry dam, 197 ft. high, with a head of water of 153 ft. In order to allay the fears of the village population the cross-section of the dam was made heavier than the usual gravity type by assuming an upward pressure at each horizontal joint due to the penetration of the water. The dam is built on a curved plan, with a radius of 820 ft.; it will be 918 ft. long on the crest. The dam will contain 327,000 cu. yds. of rubble masonry. The upstream face is battered and faced with 28 ins. of concrete, between which and the rubble masonry is a 2-in. thickness of rich trass-cement mortar. For further protection against percolation, vertical drains are provided near the upstream face, which lead into two drainage tunnels built into the base of the dam. At the foot of the upstream face the junction of the masonry and the foundation rock will be covered with puddle. This dam will be, for a short time, the largest on the European Continent.

The normal flow of the river will be used to operate an electric generating plant of four turbine units, each designed for a load of 1,500 HP., and capable of developing 2,000 HP. under higher heads than normal. The electrical works are estimated to cost $625,000, and the cost of the dam and site will be about $2,000,000.

Besides the Maurer dam, there are a 123-ft. masonry dam on the River Queis, known as the Marklissa dam, and several smaller dams on other streams. The Marklissa dam was completed in 1905 and creates a reservoir of 4,000 million gals. (U. S.) capacity. The dams for most of the remaining reservoirs are of earth fill. These embankments vary in length from 420 ft. to 9,800 ft., and store water under heads varying from 11 ft. to 57 ft. Each is provided with a masonry spillway, at the base of which a tunnel is provided of just sufficient capacity to pass the normal flow of the stream, so that the regulation of flow is automatic. Much also has been done in the way of cleaning out and straightening the stream channels and in building retaining walls along the banks. The total cost of all the works is estimated at $9,500,000.

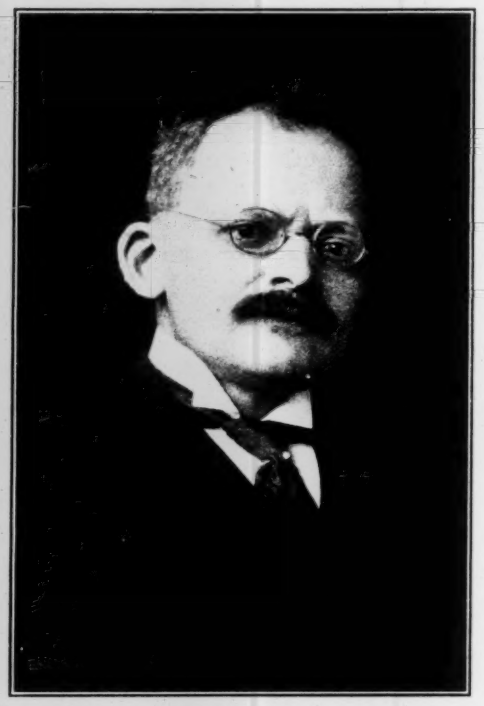
*Abstract of an article in the Engineering Supplement of the London "Times" for Nov. 1, 1911, by Mr. D. Halton Thomson.

Caryl Davis Haskins.

Caryl Davis Haskins, whose sudden death from pneumonia was noted in our obituary column of Nov. 23, was born in Waltham, Mass., on May 22, 1867. His professional education was received in England, where he specialized in mathematics and physics. He also studied surveying and fortification engineering.

Soon after the completion of his school work, early in 1887, he entered the employ of the mechanical engineering firm of Haskins, Davis & Co., of London, where some of his earliest work was in the development of gas engines and book-binding machinery. In 1888 he became a junior assistant engineer, with S. Z. de Ferranti & Co., of London, for whom he had charge of the manufacture of electrical meters, and assisted Mr. de Ferranti on the drawings for the original Deptford electric light station.

In 1889 he returned to his native country to enter the employ of the Thomson Electric Welding Co., of Lynn, Mass., as a designing draftsman. A few months later he became Electrical



Caryl Davis Haskins.

Engineer with the Thomson-Houston Electric Co., also of Lynn. Two years later he was appointed Manager of the Meter Department of this company, and upon its consolidation with the General Electric Co., he was given general supervision of the instrument department of the latter concern.

When the Spanish-American War came Mr. Haskins at once volunteered his services to the Government, organized a corps of electrical engineers, of which he was made commander, and did notable work in the protection of Boston Harbor by submarine mines and other defenses. He also aided in an advisory capacity in the construction of other defense works on the Atlantic coast. At the conclusion of the war he returned to his position with the General Electric Co., at Schenectady, N. Y.

In 1906, Mr. Haskins was appointed Manager of the Lighting Department of the General Electric Co., which position he held to the time of his death. Both from his work here and during the war, Mr. Haskins gained a national reputation as an electrical and military engineer, and his services were often in demand as a lecturer before scientific societies and institutions. He was a member of the American Society of Electrical Engineers, the American Society of Mechanical Engineers, the National Electric Light Association, the United States Naval Institute and an associate member of the Military Service Institute. He was also a member of the Engineers' Club of New York City and many social organizations in Schenectady and elsewhere.

Aside from his lectures and scientific papers Mr. Haskins was known to the literary world as the author of a number of interesting short stories. From his versatility and wide business associations he was fortunate in having an unusually wide circle of friends and acquaintances, by whom he will be greatly missed.

He leaves a widow and a young son, who were with him in Salt Lake City at the time of his demise.

Notes From a Railway Engineer's Experience in West Africa.*

By HILDER DAW,† Assoc. M. Can. Soc. C. E.

The attention of the engineering world is riveted on the Panama Canal work. The manner in which this is conducted deserves the warmest approbation; and I particularly call your attention to the fact that the chief cause of success here lies in the perfect sanitary arrangements. Without health man is an incumbrance. Without proper food a man dies by inches. Napoleon rightly said that an army marches on its stomach. Experience in the tropics will amply prove the truth of this.

To those of us who went to West Africa on railway work the British Government issued a printed agreement appointing the Chief Engineer our executor, authorized to dispose of our carcasses according to his discretion. We were told that medical comforts would be provided; nevertheless I would strongly advise all equatorial contractors to go through a course in "First Aid to the Injured"; then to invest in a case of medicines, a little book by Stanley, the explorer, and a clinical thermometer. Of course, no unqualified person should be allowed to administer the medicines contained in this case, yet I am advising you to take them where medical aid may not be available. It is extraordinary to see how little people nowadays know of the simplest remedies and preventatives.

The question of the color of one's clothes is a far more important matter than generally imagined. Naturally one would say white would be the coolest and best; yet this color is not found in nature's tints in the tropics, the wild animals are tawny or grey. It is not the heat of the sun that causes sunstroke. If it were every man in the stokeholes aboard ship and in foundries would be overcome. What does cause sunstrokes is the ultra-violet rays of the sun and the best color to cut these off is orange yellow. Therefore, the worker in tropical regions should wear an orange yellow shirt and headpiece.

Trading with the West Coast of Africa was begun by the French as far back as 1364. The Portuguese came next in 1471 and the British followed in 1551. The inducements which are causing railways to be constructed in this part of the world are, primarily, the bonuses or contributions offered by various mining companies who are paying heavily for transportation through the forest, it costing $10 to $50 a ton to get supplies from Cape Coast Castle to Obouassi, in the interior; and secondly, political and military reasons.

Formerly the route to the interior of Ashanti lay through this Port of Cape Coast Castle. For various reasons a new port was desired and the Government chose Lecondi Bay. Here a landing was made through the surf. Formerly luggage, cargo and passengers were flung upon the beach. With a high surf running many lost their lives. Now a steel landing jetty has been built which enables the boats to avoid the dangerous surf. You who land at such magnificent harbors as the United States and Canada possess, cannot realize the difficulties and dangers of making a landing on the Gold Coast.

When you arrive on the West Coast the natives give you a nickname. The first part of it indicates the day of your arrival; the other gives what, in the eyes of the native, is your characteristic. It is very difficult to find out these names, but my opinion is that according to those names you may live or die. Deaths in West Africa are ascribed to "fever." I think that very many are caused through poison administered by the natives, who are adepts at putting chopped hair and ground glass into your food. One foreman who incurred the hatred of the natives was dragged from camp and crucified upside down. We found him bitten to death by ants. Dark tales of cruelty are told around the camp fires, but sorrowing relatives hear only of the "fever."

*Abstract of a paper delivered at the annual meeting of the American Society of Engineering Contractors, Jan. 10, 1911.

†Managing Director of the Hilder Daw Construction Co., General Contractors, Montreal, Que.; formerly First-Class Government Engineer in the British Colonial Service.

Taking advantage of the railway that has already been constructed as far as Tarkwa, riding on open cars, we at last arrived at that place. Here we were given charge of more native levies, so that in our forward march into the jungle, across rivers on fallen trees, we were accompanied by about 2,000 natives, men, women and children.

Along the line of march the government has provided "Rest Houses" (usually called "Pest Houses"). After fording mountain torrents and climbing over steep paths we at last arrived at our destination, the impenetrable jungle. Here we hastily erected our tent and made a clearing of about half an acre. The reason for such a large clearing was the danger from falling trees. In the depths of the jungle one cannot see whether or not the surrounding trees are safe. Every day and night you hear the roar and crash of falling trees; yet you stand helpless in the face of death, unable to see the death-dealing timber. On the first day of my arrival at camp, a tree fell on one of my men and broke his back. In such cases, if the tree be cutable, we would get the body out for burial, but sometimes the tree would be of lignum vitae, 4 ft. or so in diameter, so then the dead was left beneath it, where the driver ants would make an end of it in a couple of days.

There is no twilight in the jungle. At five o'clock night falls upon the camp. A slight pattering in the trees warns everyone to hurry for shelter; then down comes the nightly torrential rain. No tent or palm-thatched roof can keep out the reeking dampness. Often you cannot keep out the rain. The water drops like a solid sheet of glass. One can read a newspaper by the incessant flashes of lightning. In four months we had 88 ins. of rainfall. With an evaporation of over ½-in. per day, it is impossible to keep dry or free from malaria.

As if by magic, the stars appear, as suddenly as the rain had come. In front of the tent a wood fire is built, not only for warmth, but to frighten away wild animals and snakes. Sitting by the fire, peering into the jungle, alone and shaking with ague, you are startled by the howls and shrieks from monkeys and baboons, gathered to gaze at the firelight. The snakes glide away from the fire; but apparently all other living green things come forth. They invade your letter pad in swarms and bite like a thankless child.

I might point out here that there is a very erroneous idea prevalent about wild animals. Unless they are hunger driven or have tasted human blood, wild animals of the jungle are only too anxious to avoid mankind. If driven to bay they will, of course, turn on their pursuers to defend their lives. Anyone who has lived in solitude for eight months in the jungle, his only companions being the rats playing daintily on the clay floor at night, the gibbering baboons gathered around the camp fire for the first night hours, and the glittering lizards chasing flies in the day time, will hesitate before killing a living creature save for food. Those who have dwelt in solitudes realize that "he prayeth best who loveth best all things both great and small."

Daylight comes at five o'clock; cold and shivering you face the coming day's work. Breakfast at six o'clock and out on the work at seven. Back at eleven, you retire from the heat of the day for three hours. I do not know what temperature we had, as on the first day I hung out the thermometer, the mercury ran up the tube and blew off the top.

A wind or sirocco, called the Harmattan, beginning in December, for forty days to three months, blows from the great Sahara Desert on the north. Carrying fine dust in such quantities that daylight is obscured, it fills the eyes and lungs, sweeping away the natives in droves. It is said that 75% of the native children die from this cause alone.

The work on the cuts and fills is done by workmen and workwomen with little baskets on their heads. When a stream is crossed a temporary bridge or trestle is first built and the fill made from this.

The contractors, owing to their work in trenches and cuts, have unique opportunities for making important mineral discoveries. Near one of our camps I found cinnabar and mercury in its free state. We all admit that there is an immense amount of gold in the West African territory. The attention of speculators has recently been re-attracted to the mines of that section.

Breaking the trails, bridging the waters, ever urging forward, the iron horse, with autocratic sanitary supervision following with rapid strides, will eventually hold in check the Angel of Death. The country will then become a wonderful rubber and cotton-raising province.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

505 PEARL STREET, NEW YORK

BRANCH OFFICES

CHICAGO: 1138 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

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Removal of Engineering News Publication Office.

The offices of the Engineering News Publishing Co., which have been located in the St. Paul Building, 220 Broadway, since April, 1897, have been removed this week to the headquarters of the Hill Publishing Co., at 505 Pearl St., close by the new Municipal Building now under construction and the Manhattan terminal of the Brooklyn Bridge.

The Confession of Guilt by the McNamara Brothers.

The event of greatest importance to the country during the past week has been without doubt the plea of guilty by the McNamara brothers, on trial at Los Angeles. It would be difficult to exaggerate the extent to which class hatred and anarchistic sentiments have been aroused since the labor unions espoused the cause of the accused men. Millions of workingmen, undoubtedly, have believed that the McNamaras were innocent and that they were the victims of a "capitalistic conspiracy" to blacken the reputation of labor unions by identifying them with the wholesale murder and destruction carried on by the dynamiters.

The confession of guilt made by the accused men bring home the truth to the members of labor organizations the country over as no possible evidence in a court of law could. That it will arouse them to the necessity of purging the labor organizations from such identification with crime and anarchy may reasonably be hoped. It is folly to prophesy, as some extremists do, that the revelation of this and similar labor-union conspiracies will work the destruction of the labor union movement. Labor unions are here to stay, without doubt. It is necessary to public safety that the members of the unions shall arouse themselves to the extent to which leaders of their organizations have become identified with crime and anarchy so that the law-abiding element in these organizations may assert itself.

There is no more harmful or dangerous fallacy current to-day than the fallacy that there exists a "capitalistic conspiracy" engineered by those in charge of "big business" and joined in by men of great wealth and high officials of government, and that the object of this "organized capitalism" is to reduce laboring men to a condition of serfdom.

It is belief in such fallacies that breeds dynamiters like the McNamaras, who plead in justification of their fiendish crimes that they were sacrificing themselves "for a principle." Such bitter enmity of those who work with their hands against organized society and against all the institutions beneficial to the public at large which that society has created is fraught with danger as great as that of civil war.

One can readily understand the vindictive sentiments expressed by members of the National Association of Manufacturers who have been engaged in trade union warfare for many years; but such vindictive feelings and vindictive words make matters worse instead of better. The cry of the business man is "Give us peace"; but there is no more important peace essential to business success in every line than peaceful and friendly relations between labor and its employers.

No words of condemnation can be too severe for the crimes of which the McNamaras and other dynamiters have been guilty; but the mere detection and punishment of these crimes, necessary as it is, is only the first step toward industrial peace. That must be sought, as was well expressed by Col. Meier, President of the American Society of Mechanical Engineers, in his address at the annual meeting this week, through the cultivation of friendly relations between workmen in every walk of life and those by whom they are directed and employed.

Would a Broader Gage Than the Present Be Advantageous for American Railways?

Suppose the railway system of the United States were to be constructed anew, with the knowledge and experience acquired during the eighty years since the railway era began. Would it be wise to adopt the present standard gage of 4 ft. 8½ ins. or some wider gage?

To engineers in the United States the question will appear merely an academic one; but to Australian engineers it is a question of profound importance. The new nation which is being developed through the federation of the Australian colonies is preparing to build a transcontinental railway; and before that work is undertaken it is recognized that the long pending question as to what gage should be adopted as standard for all Australia ought to be settled.

The principal facts bearing on the problem are given in a paper by the President of the Victorian Institute of Engineers printed elsewhere in this issue. In round figures Australia has 4,000 miles of railway of 5 ft. 3 in. gage, nearly as great a mileage of the standard 4 ft. 8½ ins., and 8,600 miles of 3 ft. 6 in. gage lines. There will be general agreement that the narrow gage of 3 ft. 6 ins. ought not to be perpetuated; but whether the standard gage adopted by the principal industrial nations of the world ought to be chosen for Australia or whether the opportunity should be seized to adopt the still wider gage of 5 ft. 3 ins. is a question on which American engineers will hold radically different opinions.

It is true that a number of distinguished engineers have at one time or other expressed the opinion that it would have been better had a wider gage than the 4 ft. 8½ ins. been originally adopted. We doubt, however, whether such opinions, informally expressed, and as a rule merely the result of casual consideration, should be given much weight in settling so great a question.

The argument for the broader gage, of course, is that it would permit the use of larger rolling stock. Twenty years or more ago, it was indeed felt that a broader gage would make possible the radical enlargement of cars and locomotives which was recognized to be desirable.

Since that time, however, it has been found possible to build 100,000 lb. cars and locomotives of more than 50,000 lbs. traction force for use on railways of present gage. It is doubtful whether any gain in economy would be produced on even our trunk lines of heaviest traffic by the introduction of cars or locomotives larger than those which are now possible on the standard gage. It is even doubtful whether we have not overshot the mark to some extent in our use of large cars, heavy locomotives and long trains. There is reason to believe that some railways are making a saving in their expenses for moving trains over the road and are losing what they save in increased cost of car repairs and in low percentage of car capacity utilized in paying load.

It is of course true that our large cars and locomotives are an important factor in reducing the cost of long haul freight traffic; but it does not follow that the much larger cars and locomotives which would be easily possible with a wider gage would effect an economic saving, taking the country as a whole.

It must be remembered that the problem is not what gage would give greatest economy on this or that trunk line with an enormous volume of traffic to be moved. Gains on the trunk line, even if they were secured, which is uncertain, might be more than neutralized by the losses on the thousands and ten thousands of miles of the branch and feeder lines which must be of the same gage as the main line.

It may be well to repeat here the truism that the cost of construction and of maintenance of a railway line does not vary directly with the gage of its track. In a level country where land is not expensive, a standard gage railway *for light rolling stock* can be built as cheaply as a narrow gage road. In rough country, however, where deep cuts and fills must be made and sharp curvature is necessary for economy, the narrow gage has a considerable advantage, even though the standard gage rolling stock is no heavier. Further, a standard gage road has to make provision for high capacity loaded cars received from trunk line roads, so that an increase of the size of rolling stock on trunk lines means eventually an additional expense for road construction and maintenance on the whole railway system.

It seems to us, therefore, that the railway experience of the United States would not justify Australia in adopting a broader gage for its railway system than that in use here.

The cost of hauling freight has been reduced to such a low figure with the present gage and present rolling stock that possibilities for further economies in that direction are well nigh exhausted. Further reduction in cost of transportation must be sought in other directions than increase in size of cars and trains.

The latest advices from Australia indicate that the 4 ft. 8½-in. gage will be adopted as standard for the new transcontinental line. A report by Mr. H. Deane, Consulting Railway Engineer to the Federal Government, was presented on October 11, advising the adoption of the 4 ft. 8½-in. gage as standard. Mr. Deane said:

"That gage is sufficient for locomotives of nearly four times the power of the heaviest locomotives at present in use in Australia. I have no hesitation in saying that that gage is in every respect capable of fulfilling the requirements of Australia for all time to come."

Apart from the merits of the question from the engineering and economic point of view, the 4 ft. 8½-in. gage was favored in the voting in Parliament by New South Wales, whose lines are chiefly of that gage; by Queensland, whose narrow gage lines can be changed to the standard gage with less expense than to the broader gage of 5 ft. 3 ins., and by West Australia, which desires to see the transcontinental railway built at the earliest day. The lines of 5 ft. 3 ins. gage are chiefly in Victoria, and as the expense of changing gage will fall on the several states, the members from that State were the chief ones to urge the adoption of a broader gage as the standard.

Another French Quest for the Last Germ in City Water-Supplies.

If the merciless hunt goes on, bacteria will become as scarce in France as snakes in Ireland. In our issue of Nov. 2 we told how Marseilles had concentrated filters, hypochlorite, and ozone upon a not overlarge company of germs, mostly harmless at that, and had not been content because a few stragglers escaped. Now comes Rouen, according to our French contemporary, "Eau et Hygiene," and turns ultra-violet rays on a corporal's guard of bacteria that, now and then a day, managed to pass the tortuous zooglea-lined channels of a multiple battery of Puech-Chabal filters.

This is the French story, with an occasional American sceptical comment thrown in here and there, particularly at the end:

The Société Lyonnaise des Eaux et de l'Eclairage has for some thirty years supplied the suburbs of the city of Rouen, France, with water from a number of springs rising in the hills back of the city. The supply is naturally a very pure one, but the company has taken every precaution to preserve this purity to the city mains by the most strict control of the source and the careful construction of the reservoirs and mains. In fact, in 1903, when a severe typhoid epidemic was prevalent in and around Rouen, not a single case could be traced to the suburban supply furnished by this company. In spite of this very satisfactory state of affairs, the current French craze for absolute sterility in water-supplies has led the company to undertake a series of experiments looking toward the treatment of the water by the ultra-violet ray apparatus which has been described in these columns (Dec. 8, 1910, p. 633; Nov. 2, 1911, p. 525), particularly in connection with similar experiments at Marseilles, France.

As at Marseilles, the Rouen plant comprised first two Puech-Chabal roughing filters for the successive preliminary treatment of the water, followed by one ultra-violet ray outfit capable of sterilizing 25 cu. m. per hour, or 160,000 gals. per 24-hour day. This latter outfit contained Westinghouse-Cooper-Hewitt mercury-vapor lamps, working at 3½ amp. and 220 volts, and it is estimated that the production of sterilized water is one cubic meter per 25 watt-hours, or about 10,000 gals. per KW.-hr.

The accompanying table shows the effect of the prefiltration and of the ultra-violet ray treatment on the normal water of the supply for a period of about five weeks. It will be noted that the water has a high degree of purity in its raw state and that the prefiltration renders it as pure as most engineers consider necessary. The additional purification, or rather complete elimination of bacteria, removes the last doubts regarding pollution, but at the ordinary rates prevalent in this country would cost from $8 to $10 per million gallons for electric power alone.

TABLE SHOWING EFFECT OF PREFILTRATION AND ULTRA-VIOLET RAYS* ON THE WATER-SUPPLY OF ROUEN, FRANCE.

		Bacteria. per cu. cm.		B. Coli. per 100 cu. cm.	
		Raw water.	Filtered water.	Raw water.	Filtered water.
Feb.	13	46	0	0	0
	16	67	9	20	0
	18	82	6	30	0
	21	71	4	20	0
	23	27	11	5	0
	25	33	14	10	5
March	1	9	0	5	0
	9	16	3	0	0
	11	27	0	10	0
	13	34	0	20	0
	15	86	0	20	0
	17	82	4	25	0
	22	27	0	20	0
	24	19	0	10	0

*All tests showed complete absence of bacteria after passing under the ultra-violet ray.

Is this worth while? Has Rouen and have Marseilles and the other French cities which are so hard on the trail of the last solitary germ in their water-supplies ever approached a like state of perfection in all other or any other matter affecting the public health? Are their milk supplies absolutely free from disease germs and beyond other improvement which would contribute to the reduction of infant mortality? Have these French cities gone to the full possible limit in the fight against tuberculosis? Remain there no bad housing conditions properly the subject of municipal activity?

These questions are not lightly asked, as any one can see who will study the accompanying table. The bacterial content of the raw water was low to begin with, at least as regards total bacteria. Of the 14 dates given, the filtered water showed no bacteria on seven or one-half the days, and never more than 14 colonies, while on only one day were any coli found in the filtered water, and then only 5. What possible justification can there be in going to such heavy expense to carry almost absolute perfection to its ultimate point?

Should Engineers or Politicians Be Put in Control of Highway Construction.

Is highway construction an established branch of engineering work? We had not hitherto supposed there was any doubt concerning this question; but in a press report of the recent "Good Roads" convention at Rochester we find Mr. John A. Bensel, State Engineer of New York, quoted as follows:

> It cannot, I think, be claimed that there is as yet a sufficient amount of data to place roadbuilding in a definite class of engineering. Some engineering work has to be done in connection with the work but the lack of definite data to reduce it to a science can be understood from an inspection of the work in the various states, where a larger variation could probably not be made, even if it was desired to vary for the variations itself.
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> Proper administration of highways may, therefore, be reduced to the proposition of selecting the administrators of known capacity to carry on this work and to leave them with as free and unhampered control as is possible under the laws of the state in which they are working.
>
> The commission in New York State is still so new to the business that it has a critical attitude toward everything connected with highway work from organization to construction. As an instance, I might mention probably the most insisted upon requirement of proper organization which you will hear of will be as to the necessity of taking the matter of highways in its entirety out of politics. This demand is more general among those appointed by the party that has secured the least number of votes in the last general election, but I wonder what would be left to be voted upon if all of the matters that are considered from time to time by important people as being properly outside of politics were removed therefrom.

In other words, if you want to build good roads, don't put the work in charge of an engineer because engineers haven't data enough to enable them to build good roads better than anybody else. Instead "select an administrator of known capacity;" and the political way is as good a way as any to select him.

Mr. Bensel's prominence in connection with engineering matters makes his remarks above quoted nothing less than astonishing. If it is really true that engineers are all groping in the dark in highway construction, that there is "a lack of definite data" on which to base plans and specifications, and to enable engineers to build with confidence and certainty, then it is time the public quit spending money on good roads construction until it can do so with some degree of safety.

We venture the guess, however, that a good many engineers, here and abroad, who have been building good roads for the last half century, will take issue with Mr. Bensel. Of course, it may be said that the development of the automobile and of bituminous macadam compositions to withstand its wear have revolutionized the art of road construction; but so are many other branches of engineering being revolutionized by epoch-making inventions; and the public in these other fields of engineering finds the services of the engineer all the more indispensable.

It is worth noting in this connection that the recent good roads convention at Richmond, Va., adopted a resolution to the effect that, "in order to secure desired results in road work most quickly and most efficiently, both construction and maintenance of all public highways should be under direction of experienced highway engineers, and they should be given all authority necessary to justify holding them fully responsible for the results of their work."

The Free Bridge Engineering Offer by the Office of Public Roads.

Apropos of our comment in our issue of Nov. 16 on the "free bridge engineering" bulletin of the Office of Public Roads, our esteemed contemporary, the "Engineering Record," comes to the defense of the Office as follows:

> Acting under the direction of Congress, the U. S. Office of Public Roads has been giving free engineering advice to rural communities for many years. A few weeks ago "Engineering News" discovered this fact, and worked itself up into such a frenzy over the matter that several editorial columns were needed to tell how badly it felt. It is rather late in the day to become so excited over an established and useful practice, particularly as the delegates of 22 states to the First American Road Congress have just passed a resolution commending the Department of Agriculture, of which the Office of Public Roads is a part, for its helpful assistance in bringing about the betterment of public roads. This work has been done by just the methods our contemporary so thoroughly misunderstands. They do not deprive an engineer of any work whatever; they bring work to him. The Office of Public Roads deserves the hearty support of all engineers, which should be extended particularly to its offer to furnish free engineering advice, as will be apparent when it is understood just what this really means.
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> Our contemporary then proceeds to explain that the "Bulletin" in question was not to be taken at its face value, and that it is only intended to
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> teach by demonstration what a bridge engineer does to earn his fees. The bureau will investigate the foundation conditions, prepare plans and, in special conditions, supervise the construction of bridges and culverts. While the officials of any county or state may apply for such assistance, it is manifest that it can be extended with the available funds only to those places where it will do the most good; that is to say, to those places which know nothing about engineering but are willing to put up money to permit the Department of Agriculture to show that its advice is based on demonstrable truths.

The statement of the Director of the Bureau himself as to what his offer really meant appears in our department of "Letters to the Editor" this week; and the profession at large will be interested to read his explanation.

We give full space to these statements as to the good intentions of the Office of Public Roads; but we must still express our doubts as to the wisdom or the efficacy of such methods of fostering the practice of the private engineer. In any event, we should have fallen short of our duty had we failed to come to the defense of the individual engineer throughout the country. The many letters of appreciation we have received from engineers who had seen the Bulletin of the Office of Public Roads and who thank us for the voice raised in their behalf are sufficient recompense for our "frenzy," as our contemporary terms it.

As to whether our criticism was needed or not, we advise any of our readers who may be in doubt to obtain a copy of the Bulletin referred to and judge for themselves.

The time to keep the camel from bursting into the tent is when he first sticks his nose under, is the moral of a well-known old story. However excellent the intentions of the present head of the Office of Public Roads, the furnishing of free engineering work establishes a dangerous precedent.

Engineering News has been and is a strong supporter of proper activities by the Federal Bureaus at Washington; but whenever and wherever engineers in private practice find their business interfered with by the unfair competition of any Government bureau, they may be assured that the columns of Engineering News, at least, will be prompt to voice a statement of any just grievance.

The Control of the Lower Colorado River: What Methods Should Be Adopted?

In April and May last, the United States Government spent some $900,000 under direction of Mr. J. A. Ockerson, M. Am. Soc. C. E., an engineer of long experience and high reputation, in the attempt to restore the Lower Colorado River to its old bed and avert the danger to the Imperial Valley in lower California of another break of the river into the Salton Sea. The attempt was a failure and the newspapers of that section for weeks and months were teeming with articles condemning the engineer in charge and the methods employed.

There can be no doubt that such failures of engineering work do serious harm to the whole engineering profession. At best the public, particularly in the West, is inclined to distrust the educated and trained engineer and to place its reliance rather on the man who has practical experience only.

It was through misplaced confidence in such "practical men" and disregard of the warnings of engineers that the original break of the Colorado River from its channel to the Salton Sea was brought about. Under these circumstances, the failure of last spring's attempt to turn the Colorado back to its old channel was a serious blow to the prestige of the engineering profession all through the Southwest.

It seemed to us, therefore, exceedingly important that the facts regarding this work of last spring should be put on record. It was important for the public to know whether the failure was due to mistaken methods of prosecuting the work or whether the conditions were such as to make success impossible by any methods within the range of engineering practice. Was it the fault of the engineer in charge of the work, or was the engineering profession unequal to such a task?

Further than this, it was important to the engineering profession to know the facts. One failure teaches more useful lessons to the profession than fifty successes. We have none too much information on record as to the best methods for regulating rivers flowing through an alluvial delta. Here was several hundred thousand dollars worth of engineering work swallowed up by the river it was intended to control within a few days or weeks after the work had been done. Such a phenomenal failure is as important to the profession as the breakdown of a bridge or a dam or the explosion of a steam boiler.

We therefore set about the task of finding an engineer competent to undertake the task of preparing an unbiased and accurate report upon the work in question. We consider it fortunate for our readers that we were able to secure the consent of Mr. H. T. Cory to make investigations and prepare an article for our columns.

As most of our readers will remember, Mr. Cory was the engineer under whose direction, in 1906, the breach was closed in the Colorado River banks and the flow into the Salton Sea was stopped in the nick of time to save the entire Imperial Valley from eventual flooding and destruction. The method which was originated on that work, under Mr. Cory's direction (dumping rock from trestles carried across the channel to be closed), has since been successfully used in other locations, notably on the closure of the west channel of the Chagres River at the Gatun dam site.

Mr. Cory's experience and reputation and his familiarity with the entire situation in the Colorado delta, enables him to speak with high authority. In addition it may be said that Mr. Cory is no longer connected with the Southern Pacific Co., but is engaged in private practice as a Consulting Engineer with offices in San Francisco. He was therefore in position to report as an impartial observer upon the work attempted under Mr. Ockerson's direction last spring.

We should add in addition that it was with difficulty that we induced Mr. Cory to undertake the investigation and report. He was at the time preparing a paper for the American Society of Civil Engineers (which has since been presented at the meeting of the San Francisco members of the Society on Oct. 20), and he argued that if his statements were published through that channel, Col. Ockerson and his friends could have ample opportunity to criticise or controvert anything which might be said.

In reply, however, we urged upon Mr. Cory that the facts ought to be spread before the public in defense of the engineering profession and its ability to successfully accomplish even such difficult tasks as the control of the lower Colorado River. Further, we proposed that Col. Ockerson be given an advance proof of Mr. Cory's report when prepared, with an opportunity to make reply in the same issue. With this latter stipulation, Mr. Cory consented to make the investigation and prepare the report which appears elsewhere in this issue.

We have given this much detail concerning the origin of the article which appears in this issue in order that our readers may clearly understand that Mr. Cory is not only an observer whose competence it would be difficult to equal anywhere for this particular task, but that he prepared the article at our urgent solicitation and wholly without prejudice or bias.

As for the article itself, our readers can study it and Col. Ockerson's reply and can form their own conclusions. We may, however, venture here to present a brief summary of the situation as we see it from our study of the two reports.

Col. Ockerson rests his defense of his methods on the ground that if he had been able to complete his line of levee during the low water season, the flow of the river would have been turned down the old channel and would have scoured it out so that no serious flow of water would have been brought against the new levees. To us this seems inconclusive. From data at hand regarding the sudden flood rises which come down the Colorado, who can be at all certain that the channel below would scour out more rapidly than the flood could rise?

Since no one can possibly be certain on this point, it would appear evident that any levee built to confine the river should be so designed as to prevent destructive flow along its base. If this can take place at any point, the photographs which appear in this issue (and which are testimony that cannot be controverted) indicate that breaching is certain.

Mr. Ockerson, himself, admits that there was lack of proper brush protection, and that the levee was breached in consequence, and he states that such protection was part of his plan; but why it was not made part of the original construction he does not make clear. His stated reason is that "the matter of maintenance was interpreted as not coming under the authority of the appropriation or the negotiations with Mexico." But surely this red tape restriction should not prevent so constructing the levee originally, by gravel blanketing or otherwise as to be able to endure flow against its base. If that were the case, the work had better have been abandoned before it was begun.

A word may be proper as to the value of the work not washed away. Mr. Cory sets this at some $50,000. Mr. Ockerson at some $350,000. The difference arises from the fact that Mr. Ockerson assumes that the levee which he constructed can be repaired and strengthened so that the yardage of earth still remaining in it can be saved. But if, as Mr. Cory states, there is a channel eroded along this levee by the floods of last spring, to attempt to reconstruct this levee would appear to be only throwing good money after bad.

And this brings us to what is really the most important question: what should be the next step taken to give permanent protection to the important interests involved? It must be understood clearly that the Federal Government alone has the power to act. The ten thousand residents and owners of farms and homes in the Imperial Valley are absolutely helpless, for the work must be done in Mexico. Not less than $25,000,000 of property are at stake and land which will some day be worth several times that sum may be forever ruined if wise and far-sighted methods are not adopted at the present time. The situation is so grave that mistakes cannot possibly be afforded. That serious disaster did not result from the failure of last spring's work was due only to good luck. The Colorado River floods happened to be not as high as usual. Had such a flow come down the river as has been recorded at times in the past, there might have been a different story to tell.

All who know the circumstances will agree, we are sure, that no time should be lost in effecting a permanent control of the lower Colorado, so that the wonderfully fertile lands beside it may be made available for future farms and homes. That it is well within the resources of engineering to do this, we confidently believe; but the failure of the plans of last spring, we say with regret, impels us to the belief that a radical change should be made in the methods of carrying on the work.

We regret that we have been unable to obtain for publication in this issue the official report of the Board of Engineers on the Colorado River work which was made to Secretary Fisher on June 7 last. This will be made public, we understand, by President Taft in connection with a special message to Congress.

Whatever the contents of that report, however, we believe that the critical study of the Colorado River situation made by Mr. Cory is a most valuable and important contribution to the subject and cannot fail to be taken into account by the Government in deciding upon its further procedure.

LETTERS TO THE EDITOR.

The Offer of Free Highway Bridge Engineering by the Office of Public Roads.

Sir: Your editorial of Nov. 16, entitled "An Offer of Free Highway Bridge Engineering Work by a Federal Bureau," relating to Bulletin 39 of the Office of Public Roads, entitled "Highway Bridge and Culverts," has been brought to my attention.

I am greatly surprised at the attitude taken by your journal in regard to this bulletin and its object, for it shows an entire misconception of the work of the Office of Public Roads. Our work is almost entirely of an educational and experimental nature. It is not, nor has it ever been, the policy of this Office to enter into competition with private engineers in road or bridge construction. It is, on the other hand, one of its purposes to encourage in every practicable way the employment of competent engineers on all highway and bridge work.

Much stress is laid in your editorial on the fact that no limitation is placed in the offer made to assist in bridge work. The clause, "such other information and assistance as may be practical in the individual case," was placed in the fourth paragraph on page 21 of the bulletin for the purpose of placing proper limitations upon the work which can be undertaken by this Office.

The bulletin is not written for engineers, but to make the public see the necessity for employing engineers. On page 7 of the bulletin, the first recommendation made is "that the services of a capable engineer should be secured."

The bridge and culvert work which this Office proposes to do, and upon which it is now engaged, is wholly of an educational and experimental nature, and follows the identical policy pursued for the past twelve or thirteen years in its object-lesson road work. This Office has sent out engineers all over the country building object-lesson roads, and it started at a time when the term "highway engineer" was hardly known. As a result of this work, a large number of engineers have found permanent positions, which never before existed, in both state and county road work, and a consulting practice is developing. At the present time, few engineers are employed or ever consulted in regard to the construction of rural bridges or culverts. They are largely built by the local road supervisor or carpenter, and very frequently are a menace to life and property. At best, many of the more important bridges are erected by bridge companies, the plans and specifications for which are reviewed only by the county commissioners.

I give the following as examples of what our work on bridges is accomplishing:

In the fall of 1910, an engineer from this Office built three concrete culverts in Marlboro County, S. C. They were the first concrete highway culverts built in this county. As a result of this work, the taxpayers are at present insisting upon the employment of a resident engineer to

superintend the construction of concrete culverts throughout the county, as well as to survey and superintend the construction of their roads. During the present season, two counties—Dillon and Marion—which are adjacent to Marlboro County, made application for a bridge engineer from this Office. An engineer was sent, and constructed two concrete culverts in one of these counties, which were also the first to be built there. As a result, this county has employed an engineer to superintend the building of five more concrete culverts. In Dillon County, a representative of this Office also built the first two concrete culverts, with the result that the county has employed an engineer, and, we are informed, has made a contract with him for three years to superintend their road construction and to continue the construction of concrete culverts on its public roads. It is known to be a fact that the officials in the last named county were opposed to hiring an engineer to take charge of their work before the visit of our engineer last July.

I could cite a large number of instances similar to those given above, as a result of our object lesson work. This bridge engineering work was undertaken after much consideration, and on the advice of some of our most prominent engineers, and for the Engineering News to take the stand that this Office is trying to destroy the engineering profession is preposterous.

The work of the Department of Agriculture is designed to serve the entire public, but, in this case, it happens that the engineer is the chief beneficiary. It would be equally fair for a medical journal to assume that the Bureau of Public Health is destroying the medical profession by disseminating information tending to the prevention of disease.

L. W. Page,
Director, Office of Public Roads, M. Am. Soc. C. E.
Washington, Nov. 27, 1911.

[We feel sure that many engineers throughout the country will be relieved to learn that, notwithstanding the offer made in the Bulletin referred, to the Office of Public Roads does not intend to compete with engineers in private practice. It is perhaps a fair conclusion, from the above statement, that if an engineer finds work which might come to him being offered to the Office, an appeal to that organization would be sufficient to induce it to withdraw its offer in the particular case.—Ed.]

Sir: In Engineering News of Nov. 16 appeared an article sharply criticising the action of the U. S. Office of Public Roads in offering the services of its engineers, without charge, to local officials contemplating the erection of highway bridges.

I have read and re-read this article, and still the wonder has grown, that so curiously archaic a bit of reactionism could have found expression in a journal so broad-minded as Engineering News.

You suggest that the engineers of the country should "individually and through their professional organizations, protest to the Bureau in question and to their representatives in Congress" against the "unfair competition" of the Roads Office.

As effectually and as dignifiedly might they protest against the action of the Geological Survey, in furnishing, retail, at a nickel each, topographic maps which, under the auspices of "the individual engineers who are now struggling to make a living by independent practice," could hardly be produced at five dollars each, if at all. As sagaciously might they protest against the action of the American Bridge Company in giving employment to hundreds of engineers, or against the Reclamation Service and the Bureau of Standards and of Mines for employing engineers and offering their services to manufacturers and miners. As well protest against Engineering News, which, by its skill in organizing the labor of salaried engineers and the needs of advertisers, gives us, each week, for a dime, what no struggling privateer could give us at any price.

"The public," you say, "is awakening anew to the advantages of free competition"; but the fundamental principle of free competition demands that work be done by that agency which, all things considered, can do it cheapest and best, and (if that agency proves to be the Roads Office) that the struggling private engineer recognize the inevitable and turn it to his own advantage by taking service in the governmental organization of engineers. For him to protest against governmental or other competition would be simply to proclaim that he finds himself outclassed, and that he can be saved only by artificial suppression of competition.

You ask what chance the struggling individual engineer has "against such a competition" as that of the Roads Office. The question is its own answer. He has no chance; because the Roads Office is better equipped, and "free competition" therefore demands that it have the work. Thus is our competitive "system" working its own elimination. The stronger organization absorbs or crushes the weaker organization and the individual, with the result that the public gets better service. Happily, in this case, the stronger competitor is a beneficent one, and the weaker will do well to cease from a vain struggle and adjust himself to the irresistible current of events.

You ask: "What incentive have the students of engineering to continue their work and seek entrance to the profession if the best prospect held out to them is employment in a Government Bureau?" They have the same incentive as have the cadets at West Point and at Annapolis, and one of these days we shall see governmental schools of civil (non-military) engineering, whose students will be not only prepared, but destined, for "employment in a Government Bureau," and whose scholarships will be prized as are those in our present military and naval schools. If our present engineering schools could guarantee "employment in a Government Bureau," with its assured income and tenure and its freedom from office and other expenses, the flood of applicants for admission to such schools would greatly increase. In the next preceding article you commend the Brooklyn Engineers' Club for "passing a resolution asking that Governor Dix select an engineer for appointment when the next vacancy occurs in the Public Service Commission of New York City"; i. e., virtually for "employment in a Government Bureau."

Your protest is directed against the effort of a Government Bureau to create a market for the services of engineers, who might well be glad to exchange a situation where they are "now struggling to make a living by independent practice," for one in which the "living" would be guaranteed by their 90,000,000 fellow-citizens and where the only "struggle" required would be the struggle to excel in their work.

You ask: "And if the Government undertakes to do bridge engineering work free, why not other kinds of engineering work? Why not free sewerage plans for cities and towns as well as free bridge plans? Why may not the Government furnish engineers gratis to build systems of water supply, electric lighting and power plants, public buildings for towns and cities?"

You suggest no reason why such work should not be so organized, and there seems to be none, except that we have not yet advanced quite far enough along the road from individualism (savagery) to civilization, to appreciate the eminent propriety of such action, which would advance the welfare and the status of the engineering profession, as well as those of the nation.

You say that Engineering News "has been outspoken in its support of such work by the Federal Government as it has been found necessary for it to undertake for the general welfare," but "equally outspoken in opposition to any unnecessary centralization in governmental functions."

By whom and how is the "necessity" of such concentration, in any given case, to be determined, if not by experience, if not by such enterprises as this of the Roads Office? In how many cases, when the Government has undertaken a new function, has not the undertaking at first been opposed as unnecessary or unjust, and afterward acknowledged as of the highest necessity and beneficence?

The Post Office has put some struggling couriers out of business; but no one would now think of reversing the process. Is the carrying of our letters any more properly a governmental function than the design and construction of our bridges?

In your issue of Nov. 9, commenting upon a one-sided attempt to show "ignorance, waste and graft" in the government of New York City by comparing the New York tax rate with those of other cities without making similar comparison between the corresponding results, you very properly say: "We submit that the figures cited, without supporting and explanatory statements, have little significance. A mere increase in a city tax rate is no proof of—anything, except that the rate has increased. The significant thing is the causes or objects of the increase and the returns received from increased expenditures."

Similarly, your statement that the action of the Roads Office "would mean an annual expenditure by the Office running into millions of dollars," means nothing—except that the 90,000,000 people of the United States will be taxed possibly an additional cent or two apiece. In this case, as in the other, "the significant thing is—the returns received from increased expenditure." Incidentally the protesting engineers may do well to remember that the "millions of dollars" will be distributed chiefly among members of their own profession.

You point out that a large proportion of the work, to be done by the Roads Office, under the new arrangement, will be unprofitable to the Government. So, doubtless, is the work of the Post Office on the majority of the letters which it carries to every part of the Union and to some foreign countries, for two cents each. Hence the occasional deficit in the Post Office accounts. But here is just the overwhelming advantage of governmental service (with all its admitted lack of "enterprise") over that of private carriers, who so adjust their rates as to secure, not the maximum benefit to the country at large, but the maximum profit to themselves. The advantage to the nation, of a uniform rate on letters, vastly outweighs the deficit, of a few pennies per capita, for which the Post Office is now and then held up to scorn and indignation. Similarly, the advantage, to the community, of well designed and well executed bridges everywhere, would far outweigh any resulting balance on the wrong side of the Roads Office's ledger.

Remarking upon the fact that "there is no upper limit set as to the size of structure, which the Office will undertake," you ask: "Why should not a city, proposing to build a steel or concrete bridge at a cost of a hundred thousand or a million dollars, take advantage of this free offer?"

I do not know. Do you?

You say that, if anyone holds the idea that the highway bridge construction work of the whole United States ought to be all concentrated in and directed from Washington, "the burden of proof is upon him to convince the public."

It is not easy to "convince the public" of the merits of a proposition to which it has not yet become accustomed; but I may submit that (except by crooks and by unsuccessful competitors) it has not been found inexpedient that the reclamation business, the letter-carrying business, the standardizing business, the harbor and lighthouse business, the coining business, the drug and food inspection business, and many other businesses, of the whole United States, are concentrated in and directed from Washington.

You admit that highway bridge design and construction may be taken over by State authorities without justifying indignant protest from struggling individual engineers. How can you consistently admit this? Surely the persistent struggler cannot be expected to enjoy ruin at the hands of his State Government any better than at those of his National Government.

It must be remembered, too, that, thanks to the railroad, the telegraph and the telephone, the United States is now no larger than were many of our separate States, a generation or two ago. There is no more impropriety, in managing the highway bridges of the country from Washington, today, than there was in managing New York's canals and highways from Albany, fifty years ago.

You say that "The achievements of American engineers in bridge design and construction would never have been recorded under any central bureaucratic organization." Quite true. If the United States, as a whole, had undertaken the design, construction and erection of the Quebec bridge, under a "central bureaucratic organization," as it has now undertaken the building of the Panama canal, the Quebec "achievement" would almost certainly have resulted differently.

Nowhere does the inevitable trend of things, from individual to corporate and governmental management, stand out more strikingly than in the columns of Engineering News, and almost invariably the News has shown its recognition of this trend and its appreciation of its beneficial results. It is therefore all the more surprising that the News, in this instance, should plant itself in opposition to the advancing tide, and invite the independent engineer to commit professional hari-kari by clamoring for the forcible suppression of a competitor because it can do his work better and cheaper than he.

John C. Trautwine, Jr.
257 S. 4th St., Philadelphia, Nov. 29, 1911.

P. S. Since writing as above, I have seen your issue of this date, in which your position is unanimously commended, and so warmly and by such authorities, that, at first sight, one might well hesitate to dissent. But, scratch the surface, and the motive of each of these communications appears in a Quixotic desire to defend the obsolescent against the modern and efficient, a desire

resulting in "clamor for the forcible suppression of a competing institution which can do our work better and cheaper than we." This is the keynote of all the communications. Not one of them seems to consider the public welfare worth mentioning.

Like your article, these protests are their own refutation; for they show that the competition in question is feared—in other words, needed—and therefore fair.

John C. Trautwine, Jr.

Philadelphia, Nov. 30, 1911.

[We will meet out correspondent on his own ground. If it can be shown that a Federal Government bureau can do better and more economically the work of highway bridge engineering the country over that it can be done by State organizations or by independent engineers, then in the public interest, it may properly be argued that the work should be so concentrated. But the nation's experience for the past quarter century in the operation of combinations and consolidation and in large scale operation have shown the weakness as well as the strength of centralization.

Where brains are the chief element in success, it has been amply demonstrated that the independent worker can beat the huge combination in the race of competition, provided the combination does not resort to unfair competition.

Mr. Trautwine says:

> By whom and how is the "necessity" of such concentration, in any given case to be determined, if not by experience, if not by such enterprises as this of the Roads Office?

We ask in reply, what would the success of the Roads Office enterprise prove except that a concern with all its expenses paid by the taxpayers' money could beat in competition the man who has his living to make?

If the Roads Office proposes to demonstrate that it really is able by "survival of the fittest" to do better and cheaper bridge engineering than the private engineer can do, it should charge to the clients the actual cost of the work, including the traveling expenses of its engineers sent out from Washington to build highway bridges *and culverts*, all the way from Maine to California. Even then the competition would be unfair, for the Government would furnish prestige and capital which the private engineer has to gather for himself; yet we believe the red tape and inefficiency of any such huge organization as Mr. Trautwine has in mind, would enable the private engineer to more than hold his own in competition with it.

In view of the importance of the issue which Mr. Trautwine raises, we venture a further word to indicate that this comment is made with some authority and knowledge. Twenty-two years ago, when the movement for trust organization and consolidation was beginning to attract wide attention, the writer published a book dealing with monopolies and the economic tendencies toward their creation. He was among the first to point out in detail the forces which were tending toward that centralization which Mr. Trautwine predicts. He has closely followed the progress of events since that time and while on the one hand he is a firm believer in the establishment of monopoly under Government control in many fields, such as municipal public control institutions, he is also a strong advocate of preserving free competition and the benefits of individual initiative in every occupation where conditions permit this to be done.

Most emphatically does he believe that in the work of the engineering profession in all its branches, a wide door should be kept open for the man with ability and energy and initiative to do individual work. An inevitable drawback to all large organization work, be it under a corporation or under Governmental control, is the stifling of personality. It is even more important to the public that we develop great men in the engineering profession than that engineering work should be done in the cheapest way.

And until Government engineering work in this country is put upon an entirely different plane as regards compensation, tenure of position and recognition for meritorious achievement, there is precious little inducement for able and ambitious young men to look forward to it as a life career.

Finally, we may suggest that Mr. Trautwine's letter is an illuminating reply to Mr. Page's above, since it shows the impression made upon the mind of an engineer by the terms of the offer published by the Office of Public Roads, and shows directly where it would lead if it were taken at its face value.—Ed.]

Sir: I have read with a good deal of interest both your editorial on Bulletin No. 39 issued by the Office of Public Roads, and the comments thereon in your issue of November 30, by various correspondents. Now I have taken and read your valuable paper continuously since 1880, and have the issues back to 1875, and believe you are generally right in the position you take on engineering questions; but in this particular case I do not think so.

I think you have entirely misjudged the purpose of the Public Roads Department, as expressed in their bulletin, and sounded an alarm that is entirely uncalled for. I do not believe it is, or ever has been, their purpose or policy to enter into competition with individual engineers or engineering firms. If I understand the matter correctly, it has been their uniform and consistent policy to encourage the employment of competent engineers on highway work, and when I read the above bulletin some months since, I supposed it was their purpose to encourage rural communities to deal intelligently with their highway bridge and culvert work.

The officials of a great many of our rural communities on account of the expense involved in consultation, will not employ an engineer and owing to their ignorance in such matters, not knowing anything about the relation between the loads which come upon a bridge and the resulting strains in its members they are the dupes of irresponsible bridge building concerns who put up structures that are often incapable of sustaining modern traffic and particularly the modern steam roller.

Some of them are so weak that they have failed under the weight of a three-horse load of goods.

Many of these officials do not know enough about such matters to see the need of any kind of an engineer in the design of such structures. If they are told by the agents that the bridges are of steel, if they look well, if they have a place to attach a name plate whereon the names of these officials may appear, and especially if the bridges are cheap, they at once appeal to them and they have no use for what seems to them as a high priced engineer any more than they have for a surveyor to make a survey or plan of their land when they purchase a farm and are ready to accept a description based upon a magnetic meridian survey made fifty or a hundred years ago nobody knows when, or one bounded on Mr. So and So's land.

The bridge engineers have had a chance or whack at this kind of work for the last 30 years and so far as my knowledge goes they have not found it a very fertile field for their efforts. As I understand it, the purpose of this move on the part of the Public Roads Department is to instruct rural communities in reference to the importance of considering and managing such matters on a scientific basis, that they expect to labor in fields where engineering services are at present not much employed and in places where there is an undercurrent of sentiment unfavorable to the employment of an engineer.

Such communities, if they think they can get the services of a reliable adviser for nothing may be induced to employ him and thus gradually to see the need of employing competent men in all such cases. That there is need of thousands of better bridges and culverts in our country places, all I think will admit, and I believe that the result of this effort on the part of the Public Roads Department will be to create more work for professional engineers rather than less.

The object lesson work of this department, in my judgment, has been of great value in stimulating rural communities to improve their highways and I have supposed that a good many engineers were finding employment as a result. I know of some certainly who are finding such employment and think the result will be the same in this new line of effort.

It seems to me your position in this matter as indicated by your article is a good deal like that of the early operatives in our cotton and woolen mills when they looked with dismay upon and resisted the introduction of modern machinery, thinking its use would put them out of business. History shows us that this was not the ultimate result. The present corps of bridge experts connected with the Public Roads Office cannot with all their other work, do very much towards supplying the work needed in this direction, and if they should even begin to do what your article seems to assume that they are going to do, they must employ the services of a good many bridge and culvert engineers.

Their work has been almost wholly of an educational character and experimental, and in a large measure supplemental to that of our educational institutions. I understand that they are now carrying on a series of tests relating to bridge and culvert work which will be of general value to bridge engineers and road builders. Many rural officials think that they can build short span bridges and culverts in any old way and oftentimes in ways that have little permanency in respect to efficiency or durability, and structures which frequently cost more even in a short time than a properly designed and built one would have done.

If the above Department can give our rural communities any light on such matters that they will accept and follow, it seems to me they ought to be allowed and encouraged to do it, and that the engineering profession as a whole will profit by it financially and in every way.

In your issue of November 30, a correspondent under the title of "Roads Engineer" refers to and quotes from a poster issued in Elkton, Md., and saying that "The United States Road Commission will make the survey free of cost and give the services of an engineer to superintend the construction of a good road, etc." The inference is that our friend regards this as a trespass upon the rights and prerogatives of our profession.

I do not think so, on the other hand, in all probability, if something of this kind were not done that community would not do anything in the way of improving their roads. So far the efforts of the United States Roads Commission in the above direction have been limited to the construction of sections a few hundred feet in length and in a very limited number of localities.

Our friend the "Roads Engineer" in the same issue makes the inquiry, "Where is all this free help idea going to lead to?" I would answer to more work for him, if he understands his business and keeps up with the times and his profession.

I have taught the subject of highway construction for the last 30 years, am much interested in it and have had some practical experience in that particular line, and as already stated I have read the columns of your paper for as many years and it seems to me your view of this matter as presented in your columns is the most short-sighted one that I have ever seen advanced in those columns on an engineering question, and that if the suggestions of some of the correspondents are followed in reference to the above department it will be materially hindered in a valuable line of work.

John V. Hazen.

Hanover, N. H., Dec. 2, 1911.

Filtered Water for All Philadelphia became available on Nov. 21, 1911, with the opening of the 70,000,000-gal. plant at Queen Lane. Philadelphia now has five seperate plants, with a combined capacity of 385,000,000 gals. Most of the water is prefiltered at a rapid rate before going to the slow-sand filters, and a small portion of the water which is not prefiltered has the benefit of sedimentation. In round numbers, the water consumption of Philadelphia is 200 gals. per capita. The total filtering capacity is but slightly in excess of the present average total daily consumption and in some districts there is practically no margin between filter capacity and consumption. In the West Philadelphia district the filter capacity could be increased from 43,000,000 to 60,000,000-gal. capacity by an expenditure of some $30,000 for changes in the preliminary filters, but the water pipes in the district will carry no more water, so nearly $600,000 is needed for larger mains. The immense filter plant at Torresdale, on the Delaware, is called on to deliver an average of 220,000,000 and a maximum 240,000,000 gals. a day. The larger figure is not only the capacity of the filter plant, but also that of both the low-service and the high-service pumps and the long lines of pumping and distributing mains. Unless means are taken to restrict waste, the enlargement of the Torresdale filters, pumping stations and distributing system must soon be entered upon at an estimated cost of $10,000,000 to $12,000,000. Mr. Fred C. Dunlap, M. Am. Soc. C. E., is Chief of the Bureau of Water of Philadelphia, and has kindly given us the information on which this note is based.

A Multi-Ported Back-Pressure Valve.

A back-pressure valve with a number of openings instead of the single port of the usual type is shown in the accompanying illustration. This valve is the invention of Mr. Axel B. Wallem, of Delaware Co., Pa., and was patented in December, 1910 (No. 979,811) but has only recently been put on the market. The advantages claimed

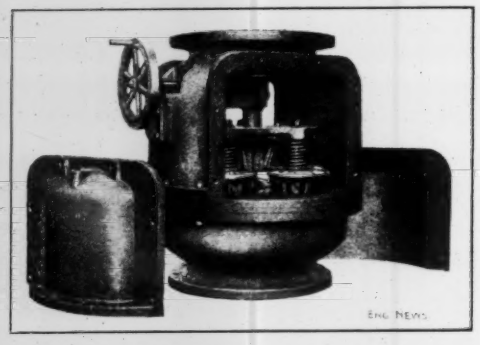
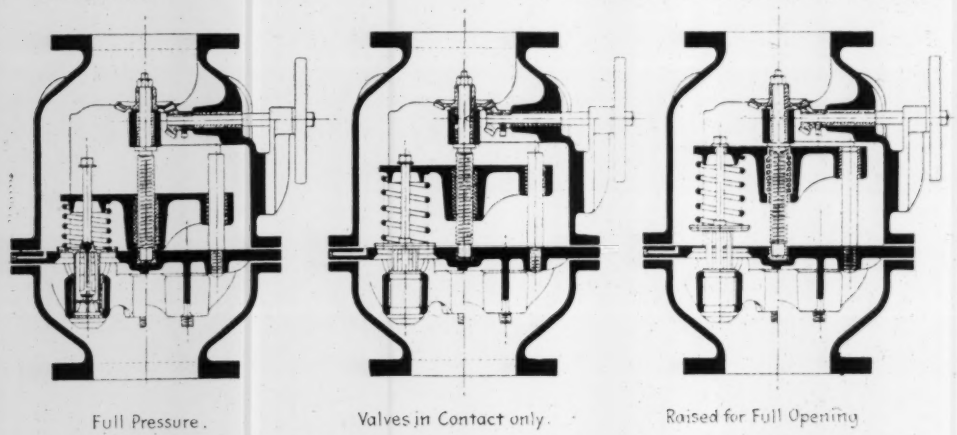


Fig. 1. Cochrane Multi-Port Back-Pressure Valve.
(Hand-hole covers removed to show valve deck; pressure plate raised to give free exhaust to atmosphere.)



Full Pressure. Valves in Contact only. Raised for Full Opening

FIG. 2. SECTIONAL VIEWS OF COCHRANE BACK-PRESSURE VALVE WITH PRESSURE-PLATE IN DIFFERENT POSITIONS.
(Valve disks are of bronze, as are also the linings of the dashpots beneath each disk.)

for the multi-port construction are greater effective opening for a small rise, better security against sticking and less likelihood of injury to the valve in hammering on its seat.

One of the most general uses of back-pressure valves is in connection with exhaust-steam heating systems. Here they act as safety-valves to prevent the exhaust-steam pressure from rising high enough to injure the heating equipment or stall the engines from which the steam is taken. In case the exhaust steam from the engines accumulate faster than it is condensed by the heating system, the back-pressure valve opens and steam escapes to the atmosphere until the pressure is reduced again to that for which the valve is set. The back-pressure valve on a heating system would be set ordinarily for a pressure between 5 and 10 lbs. per sq. in., and a much larger opening is required to discharge the steam at a given rate than is needed in a boiler safety-valve, since both the velocity and density of the steam are less at the lower pressure.

The construction of Mr. Wallem's valve is evident from Fig. 1. The valve deck, and consequently the casing or body of the valve is made somewhat larger in diameter than the pipe to which it is attached, in order that the total opening through the ports may be made equal to or larger than the bore of the pipe. The valve shown has six ports, covered by a separate valve disk. Each disk is held to its seat by a separate spring but the pressure of all the springs, and hence the pressure at which the valve will open, is controlled by a single "pressure-plate" bearing upon the upper ends of the springs. The pressure-plate can be raised to decrease the spring pressure, or lowered to compress the springs, by means of a hand-wheel which drives, through bevel gearing, the vertical lead screw turning in a nut at the center of the plate.

The pressure-plate is shown in three positions in Fig. 2, which gives some idea of the range of pressure at which the valve can be set to open. The dash pots under each valve disk to prevent chattering are shown in this figure. Their cushioning effect depends on the accumulation of condensation water from the steam.

In one view, the plate is shown at its highest position with the valve disks lifted clear of their seats. In this position, the disks are out of action and a free opening is given to the atmosphere. The valve would be set in this position, for example, when the steam was to be shut off from the heating system and the engines run with atmospheric exhaust. Another case where this position would be used occurs when the valve is used as an atmospheric-relief valve on a condenser. Here the valve acts as a safety valve to prevent a dangerous rise of pressure in the condenser in case of failure of the condensing-water supply. It is held open, by raising the pressure-plate, when starting the engine or turbine with atmospheric exhaust before putting the condenser in operation.

The valve is known as the Cochrane multi-port safety exhaust-outlet valve, and is manufactured by the Harrison Safety Boiler Works, 3166 North 17th St., Philadelphia, Pa., to whom we are indebted for the information and illustrations used in the preparation of this article. This company controls the patents protecting the features involved.

Suggestions for a Model Street Railway Franchise.[1]

By J. W. S. PETERS[2] and DELOS F. WILCOX.[3]

While we do not favor the granting of a street railway franchise that is exclusive in legal form, we do believe it to be for the best interest of all concerned that the entire street railway system of a given community should be operated as a unit under one comprehensive franchise. In other words, we favor a practical though not a strictly contractual monopoly.

We would even go so far as to suggest the advisability, under certain conditions, of a practical consolidation of the street railway and the electric light, heat and power systems, because of the economies to be effected by joint management.

In our opinion every franchise should describe the specific routes over which the lines are to be operated, with an adequate provision for extensions or relocations of original lines under the terms of the franchise, thus avoiding the necessity of negotiating a new contract whenever a modification or extension of routes is to be made.

It is our opinion that one of the necessary corollaries of monopoly in street railway service is the obligation on the part of the franchise holder to exend its lines from time to time when required by the city, subject to review as to the reasonableness of the requirement. It should not be necessary to show that a particular proposed extension will be an immediate source of profit. The test of the reasonableness of an extension from a financial standpoint should be whether or not the entire system will still be able to earn a fair profit on investment after the extension is made. Within these financial limits extensions should be made so as not only to furnish transit facilities to districts already built up, but also to relieve and prevent congestion of population and provide for the esthetic development and symmetrical growth of the city.

The city should reserve the right to build extensions either out of its general fund or out of the retirement fund or by means of special assessments on benefited property, and to require the grantee of the franchise to operate such extensions as a part of its street railway system upon fair terms as to rental.

We are of the opinion that all franchises should be indeterminate within the maximum limits permitted by law, and that when the indeterminate principle is accepted as the policy of the state such maximum limitations should be eliminated by a change in the law.[4]

An essential element in the purchase clause is the fixing of the price at which the property may be taken over, or the exact description of the method by which such price is to be determined in the future. In our judgment it is preferable that the price should be agreed upon between the parties at the time of entering into the franchise contract, provision being made for adding to this price from time to time the legitimate cost of extensions and betterments. An essential element in arriving at the price originally agreed upon is a valuation of the physical property. Our reasons for preferring a present valuation to a future appraisal are that by this means the city is enabled to know at any time exactly what the property will cost if taken over; that the franchise itself, supplemented by the extension and betterment accounts, will furnish at all times a definite basis of capital investment for rate regulation and for amortization charges, and that all the financial relations between the city and the company will be upon the basis of protecting the actual original investments without reference to appreciation or depreciation of land values, prices of labor and material, cost of street work, etc.

The fixing of the purchase price and capital value in the contract itself release the city from any necessity of providing for the supervision of stock issues. As to bonds, it is desirable to provide in the franchise that they shall be sold at the fair market price and shall be callable for amortization purposes at a small premium over the price at which sold.

We believe that in order to make the city's control of its streets effective, a practicable method of substituting municipal for private ownership should be available to the city at all times. In view of the enormous burdens of a city, increasing in even greater proportion than population, it is clear that the mere provision of a purchase clause in a street railway grant does not leave the way open practically to municipal ownership in the future unless in the grant itself some method is provided for the reduction of the purchase price or for the accumulation of a fund with which to effect the purchase. If the compensation and taxes paid to the city by the franchise holder are treated as an item of revenue, to be used for the relief of general taxation, the city will not be accumulating a purchase fund. Furthermore, if the franchise holder pursues the usual policy of public-service corporations, of continuous increase in capital investment without any decrease by amortization, the purchase price will become greater and greater as time goes on and thus tend to make purchase by the city at some further time even more difficult than at the date of the contract.

We therefore suggest that either the city should set aside all or a sufficient portion of the revenues received by it from the street railway company as an amortization or sinking fund for the purchase of the company's bonds from time to time, and ultimately to offset the company's

[1] Extracts from a Report by the Sub-Committee of Committee on Franchises of National Municipal League, presented at Richmond, Va., Nov. 16, 1911. The report has not yet been passed upon by the full committee, but was submitted for general discussion. It includes an outline or synopsis of a model street railway franchise, to serve as a check list in drawing franchises as well as for purposes of discussion. The full sub-commitee report will probably be printed in the "National Municipal Review" (or a Supplement), a new quarterly to be started by the National Municipal League, North American Building, Philadelphia, in 1912.

[2] President of City Club of Kansas City, Mo.

[3] Chief of Bureau of Franchises, Public Service Commission for the First District, New York.

[4] By an "indeterminate franchise" we mean a franchise that may be revoked by the city upon due notice given, either at any time, or at any time after a short minimum period or at regular intervals not more than five years apart, such revocation in any case to be conditional upon the city's taking over the physical plant at a fair price or designating another grantee to do so.

entire equity in the property, or that the company itself be required as one of the conditions of its franchise to set aside annually in the hands of trustees a certain percentage on its investment sufficient, with the normal accumulations, to amortize the capital within a period of from thirty to fifty years. All accumulations of the amortization fund should under the contract itself go to reduce the purchase price in case the franchise is terminated. At the end of the amortization period, if the city has not already purchased the property, the entire physical plant will revert to the city without further cost, either to be operated by it or to be leased for operation, as public policy may at the time dictate. In either case the plant can be operated free from capital charges. . . .

We would also suggest that the franchise contain a clause binding the grantee in case of purchase by the city to accept mortgage bonds of the city in payment, to as great an extent as would be compatible with their being readily negotiable, such bonds to be secured only upon the property and revenues of the street railway plant, including the right in case of foreclosure to retake and operate the plant upon the same terms as before. . . . [This would] simplify the financial problems involved in the change to municipal ownership, by eliminating brokerage charges and at the same time leaving the company's investment largely undisturbed.

. . . . . .

Where the negotiation of a new franchise settlement involves the surrender by the company of existing unexpired franchises, held under conditions already fixed by contract, it may in some cases be necessary to include their estimated value in the purchase price. If this is done the new franchise should certainly provide for amortization within the original period of the old grants of at least the part of the purchase price allowed for unexpired franchise value. Care should be taken, however, in valuing an existing franchise not to take into consideration merely its earning power during its unexpired term, but also the fact that under old grants in most cases the physical investment itself would be left "up in the air" when the franchise expired. The value of the greater certainty offered by the new franchise should be counted as an offset against the unexpired earning power of the old one.

The upshot of the whole matter is, that while a city can well afford to allow a fair price in providing for the purchase of an existing utility, for the sake of getting its complex relations with the former franchise owners disentangled, it cannot afford under any circumstances to pay a price approximating the capitalization which has already bankrupted the private owners.

A street railway should be regarded as a public necessity, to be maintained at all times at the highest practicable standard of efficiency, irrespective of the expiration or termination of the franchises and irrespective of changes in ownership or in management. While this policy is necessary in any case it becomes doubly necessary when the city enters into a contract reserving the right to take over the property at a fixed price at some future time. The franchise should, therefore, contain specific provisions in regard to the disposition of earnings, to the extent of requiring certain percentages of gross receipts to be set apart from year to year for maintenance and depreciation, including obsolescence.

In our opinion the first consideration in the operation of a street railway should be the rendering of sufficient first class service. In order to secure this result practically, the franchise should not only reserve to the city specific and comprehensive regulatory powers, but in all cases where there is no existing state or local authority for the purpose should make provision in detail for a supervising commission or officer, with adequate means for enforcing the contract and compelling the grantee to give such service.

The second consideration, in our judgment, should be the protection of the capital legitimately invested in this public service. The aim should be to make street railway securities approximately as safe as municipal bonds. We esteem it a disgrace to a city either to lend the use of its streets for the exploitation of the credulity of unwary investors or to impose such severe restrictions upon capital honestly invested in a public utility as to drive the franchise-holder into bankruptcy. We also think it to be a lamentable error in public policy for a city by laxity in supervision to permit the grantee of its franchises so grossly to mismanage a public utility and overload its capitalization as to deprive the public of adequate service and at the same time endanger the security of invested capital.

We consider that while the question of street railway fares is of great importance it is after all secondary to the furnishing of adequate service, to the honest protection of necessary investment and to the gradual amortization of the capital for the benefit of the city. We think that the franchise should prescribe an initial rate of fare, but should provide for an occasional readjustment either through regulation or by means of an automatic schedule of rates specified in the grant itself. An interesting experiment with the latter policy is now being made in Cleveland, and the final results there will throw important light upon this method of adjusting rates. Whatever rate may be in force at any particular time we think that as far as practicable it should be uniform within the city limits, and that a general system of transfers without extra charge should be provided.

We have considered with care the question of compensation for franchises. In our judgment the car riders should not be taxed for the relief of the general tax rate. While there are strong arguments for the policy of requiring a franchise holder to pay taxes at the regular rate on the value of its property outside of the streets, we think that at least all compensation in excess of this requirement, whether in the form of general city taxes, car license fees, a percentage of gross receipts or a division of net profits, should be applied either to the construction of extensions on the city's account, or to the amortization fund, or should be remitted for the benefit of service or for the reduction of rates.

The public necessity of maintaining continuous service on a street railway system is so great that in our judgment the franchise should provide some method for the arbitration of labor disputes so as effectively to prevent strikes.

We have been impressed by observation and experience with the tremendous cost in human vitality represented by the time and energy wasted in transit. It is often true that a half hour or an hour spent on a crowded, poorly lighted, badly ventilated street car at the end of a hard day's work is a greater tax upon a person's strength than an extension of the day's labor for the same time would be. The cost of transportation is not to be measured merely by the fares paid. The representatives of the city in framing a street railway franchise contract and in the regulation of street railway service should constantly keep in mind the conservation of human energy as well as financial considerations.

Work of the International Electrical Congress and the International Electrotechnical Commission at Turin, Italy.

INTERNATIONAL CONGRESS.—Detailed reports of the International Congress of Applied Electricity, held at Turin, Italy, Sept. 10-16, have recently been received in this country. It appears that nearly 500 members were present, including delegates from various governments and from engineering societies in different countries. During the several sessions, papers were presented for discussion on advances in generating machinery and transformers; central power stations, switchboards, conduits, etc.; instruments and methods of measurement; illumination and heating; electric traction; telegraphy and telephony; electrochemistry and electrometallurgy; rates, taxation and legislation, etc.

The Congress asked the International Electrotechnical Commission, as a permanent and official body, to assume the responsibility for the organization of future electrical congresses as to time, place, object, etc.

At the close of one of the meetings, the French, Americans and Germans in attendance decorated the monument of Galileo Ferraris.

The Congress endorsed the action of the American Institute of Electrical Engineers in giving in its publications metric equivalents of all values stated in English measure. It was also recommended that the technical societies of all countries where the metric system is not official should follow this practice.

The Congress voted that it was desirable to have an International Commission named for the study of systems of illumination and of all technical problems dealing with illumination and approved the proposal to have the Illuminating Engineering Society of London appoint such a commission.

The Congress also voted that acceleration of trains should be expressed in kilometers per hour per second. It was further voted that in matters of electrical legislation the codes of legal and technical provisions should be entirely separate. Resolutions were passed against the imposition of taxes upon the generation of power, except for lighting or in the case of private plants, and that legislation should not be of such a nature as to give any system advantage over electricity.

A number of members requested that the next international congress have an educational section, since many countries lacked those societies for the furtherance of technical education found in the United States.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.—The International Commission held a series of meetings, beginning with Sept. 7. Nineteen countries were represented by 52 delegates. Mr. Emil Budde, of Germany, was elected President, and Col. R. E. Crompton, of England, was re-elected as Honorary Secretary. Among the different actions taken, the following should be noted:

Instantaneous values of electrical quantities which vary with time are to be represented by small letters (lower case). Virtual or constant values of electrical quantities are to be represented by capitals. Maximum values of periodic electrical quantities are to be represented by capital letters, followed by the subscript *m*. Magnetic quantities, constant or variable, are to be represented by capital script, Gothic, heavy-faced or any very special type. Maximum values of periodic magnetic quantites are to be followed by the subscript *m*. The following quantities are to be represented by the specific letters shown:

Current	I, i
Electromotive force	E, e
Resistance	R
Electric quantity	Q, q
Inductance (coefficient of self-induction)	L
Magnetic force	$\mathfrak{H}$ or $\mathbf{H}$
Magnetic flux-density	$\mathfrak{B}$ or $\mathbf{B}$
Length	L, l
Mass	M, m
Time	T, t

The term "reactive power" was adopted for the quantity "$E\ I \sin \phi$." On the request of the American Institute of Electrical Engineers, the Commission took action toward securing uniformity of representation of vector diagrams. This request was made a year ago, because of the confusion which arose from having two methods of representing varying electrical quantities. One method used rectangular coordinates, and the vector was a supposedly revolving (anti-clockwise) line, whose projection on a fixed line represented instantaneous value of the varying electrical quantity whose maximum value was given by the length of revolving vector. The various angles of rotation represented motion or sequence of events of a cycle, and the line representing maximum value of current would be plotted a certain angle behind that representing voltage in case of "lagging" current. The other method of representation is based on polar coordinates, and actual time is represented by an angle, the radius vectors representing instantaneous values. With "lagging" current (maximum value occurring later than maximum value of voltage), the current vector would be plotted ahead of the voltage vector, the time angle being greater. Hence, confusion of ideas in the study of different texts is induced. The Commission went no further than to recommend that in graphical representations advance in phase should be represented in the counter-clockwise direction.

Three recommendations were adopted in regard to the rating of electrical machinery: (1) Output of generators is defined as electrical power available at terminals; (2) output of electrical motors is defined as mechanical power available at the shaft; (3) both electrical and mechanical power are to be expressed in international watts. A committee, consisting of one member from Belgium, France, Germany, Great Britain, Italy, Sweden, Switzerland and the United States, was

appointed to continue the study of rating of electrical machinery.

The proposition of the International Electrical Congress that the Commission should undertake the organization of future electrical congresses was accepted, and it was decided to hold a congress at San Francisco in 1915. Meetings of the International Commission were fixed for Berlin in 1913 and San Francisco in 1915.

The Interstate Commerce Commission's Report on the Lehigh Valley R. R. Wreck Near Manchester, N. Y., on Aug. 25, 1911.

The wreck of a passenger excursion train on the Lehigh Valley R. R. at Manchester, between Rochester and Geneva, N. Y., on Aug. 25, 1911, aroused considerable interest on account of the large loss of life and more particularly because of its being clearly attributed to a defective rail. This rail was found, after the accident, to be broken into some 17 pieces, and both the report of the New York State Public Service Commission and the official statement of the railroad company agreed that the rail was not only "piped" but had also certain defects about the head that were described as "hard spots" or "growing defects."

The pieces of the rail were subsequently examined carefully under the direction of the Interstate Commerce Commission by Mr. James E. Howard, Engineer-Physicist of the U. S. Bureau of Standards. The result of his examination is the subject of a long report to Dr. S. W. Stratton, Director of the Bureau of Standards. Upon the information given in this report, as well as upon the results of his own investigations, Mr. H. W. Belnap, Chief Inspector of Safety Appliances, Interstate Commerce Commission, has based his report, recently submitted to the Commission, an abstract of which follows:

The train was composed of 14 cars, with two locomotives, Nos. 2476 and 1804, at the time the accident occurred. At the west end of the Manchester yard, the signals were set as usual at caution and the speed was reduced to 25 mi. per hr. At the east end of the yard, the engineers began to increase the speed, so that at the time of the accident the speed was probably a little over 25 mi. per hr.

At a point 247 ft. west of the bridge spanning Canandaigua Outlet, the train was derailed by a broken rail. The rail was fractured on the north side of the track on which the train was running, abreast a crossover. The two engines and first five cars passed over the bridge in safety, but a part of the train was precipitated from the south side of the track, the side opposite the broken rail, to the bed of the creek. The fractured rail was several rail lengths east of the Manchester yards, the bridge several rail lengths farther on. One car from the middle of the train fell to the bottom of the creek and was demolished, the forward end of the next car falling also, leaving the rear end resting against the bridge. In these two cars, day coaches, the majority of the casualties occurred. All the remaining cars were derailed.

A thorough examination of the train failed to disclose any defective condition of equipment.

The Lehigh Valley R. R. maintains at the point of the accident a double-track line running east and west with 90-lb. steel rails 33 ft. long, double spikes, class "A," ties 18 to the rail. The grade is practically level. The bridge crossing Canandaigua Outlet is a steel-girder deck bridge, about 178 ft. long, of two bents, having substantial masonry abutments with a stone pier located in the center.

On the north and south sides of the main tracks, west of the bridge, is the Manchester freight yard. There is a highway crossing 578 ft. west of the bridge and between the crossing and the bridge is an interlocking crossover. Trains are operated by the Hall Automatic Block Signal System, electrically operated. The fact that all signals were at clear makes it plain that the rail could not have been broken prior to the time train No. 4 entered the block.

This being true, it is probable that as steam was being admitted to the cylinders of both engines, it withdrew much of the load from the pilot wheels and put an excessive load on the driving wheels so that a maximum wheel pressure was applied to this defective rail, causing it to break. The cars following caused additional fractures until the forward trucks of the sixth car dropped to the ties. The rail was broken into about 17 fragments, the first 31 ins. long, the next 27 ins., the next 22 ins. and so on. It would seem to harmonize with the appearance of these short fragments to believe that the primary fracture was caused by the locomotives and that one by one these short pieces were detached after the severe hammering they sustained. With the spikes loosened by the pressure, the fissures existing in the head of the rail (referred to later on) would facilitate the rapid rupture of the rail.

The total weight of the two engines was distributed as follows:

Weight.	No. 2476 lbs.	No. 1804 lbs.
On driving wheels	99,700	154,800
On front trucks	53,800	44,700
On back trucks	43,000	...
Total, engine	196,500	199,500
Total, engine and tender	339,200	342,200
Wheel base.	**No. 2476 ft. ins.**	**No. 1804 ft. ins.**
Driving	6 11	14 1
Rigid	14 1	14 1
Total, engine	25 8	26 1
Total, engine and tender	69 9½	67 1½
Number of driving wheels	2 pairs	3 pairs
Diameter of driving wheels	77 ins.	69 ins.

The broken rail was manufactured by the Bethlehem Steel Co., open-hearth process, 20% discard, 90 lbs. to yard, and was rolled Dec. 24, 1909. It was known as an "A" rail, the first rail rolled from the ingot. It was first laid on Oct. 31, 1910, but was subsequently removed and shortened to 24 ft. An examination after the accident showed the following composition of the material in the split in the web:

SiO_2, 23.2%; Al_2O_3, 20.5%; CaO, 40.8%; MgO, 7.5%; not determined, 8%.

The 8% not determined comprised Fe_2O_3, TiO_2, P_2O_5, Mn_3O_4, H_2O, CO_2, a little coal, perhaps SO_3 and alkalies. From the above composition it is inferred that this slag-like material was rolled into the rail through the several passes down from the ingot earlier than coming from the ladle and had its origin in the steel furnace.

In the head of the rail are transverse fissures, which could not have been detected except by chance, but which were more dangerous than "piping." Rolling of the head of the rail by heavy wheel pressure produces internal strain in the steel, which reached its greatest intensity on the gage side of the head of the rail, where the flow of steel takes place in a lateral direction. No foreign substance is necessary to account for these fissures and they invariably occur on the gage side of the rail. From these and other facts, it seems that these fissures are not defects of mill practice and do not exist in new rails.

The development of these transverse fissures suggests that the limit of wheel pressure has been reached and probably surpassed on rails of the usual width and shape of head and that the increasing occurrence of accidents of this character is warning of the fact. In 1902, 78 derailments occurred due to broken rails, in 1911, 249.

Letters from the Division Engineer and Supervisor of the Lehigh Valley R. R. are submitted to show that the railroad was cognizant that there were defective rails in service and formal notice was given foreman of track to look out for them. When the rail was cut down to 24 ft., it is plain that the defect could and should have been discovered before replacing the rail.

SUMMARY RECOMMENDATIONS.—The accident was caused by a broken rail. The primary cause of the break was the formation and development of transverse fissures and longitudinal seams in the head of the rail, finally causing it to break under excessive wheel pressure. Secondarily, the cause was "piping," a defect in mill practice.

Defects were such that when it was once laid, no amount of inspection, no matter how careful, would have disclosed them, but when the rail was removed and cut and holes bored for fish plates, these holes as well as the cut head must have shown evidence of piping. The rail should therefore not have been put back into service.

With the information at hand, it is extremely difficult to suggest any means of preventing further accidents of this character. The remedy lies in diminishing the wheel pressure and lowering the direct compressive and bending stresses. An exhaustive examination and tests should be begun, with most complete and careful experiments, covering the whole question. This examination should deal with steel rails from the furnace to the time they are laid in the track; it should determine whether the tests now used in the steel mills are adequate to detect imperfections in the rails; it should ascertain whether the use of high-carbon steel is not attended with danger not recognized in the drawing of specifications now current; it should be extensive enough to inquire into the causes which contribute towards such a destruction of structural integrity of steel as was the case with this rail; it should take up methods of securing measurements in the track of the actual fiber stresses caused by the new types and weights of locomotives. In fact track conditions as they exist at the present time should be dealt with even to the most minute detail.

The danger zone in use of steel rails has been reached, and since transverse fissures are the direct result of high wheel pressure, a complete investigation should be made for purposes of scientifically determining the matter and ascertaining a remedy. Until such an investigation has been made the danger of similar accidents will exist. Such an investigation is therefore recommended.

The Manufacture of Agricultural Implements In the United States During 1904 and 1909.

The manufacture of agricultural implements is the subject of a preliminary report issued by the U. S. Census Bureau. This report contains comparative summaries for the years 1904 and 1909, prepared under the direction of Mr. W. M. Steuart, Chief Statistician for Manufactures. The most important figures are summarized in the accompanying table. From this table it is seen that there are increases in all items for the year 1909 over 1904, except in the number of establishments. The capital invested includes "owned" and "borrowed," but does not include values of rented property or plant. The value of products relates to actual production rather than sales. Cost of materials excludes all unused supplies. The item of "miscellaneous expenses" includes rent, taxes, contract items, and unclassified office expense.

It is seen that implements of cultivation form the largest class, constituting 65.6% of the whole number. Harvesting implements are shown to be next in magnitude of numbers, being 21.1% of the whole. Plows form 49.1% of all cultivating implements and 32.2% of all implements. The table permits further interesting comparisons.

THE MANUFACTURE OF AGRICULTURAL IMPLEMENTS IN THE UNITED STATES.

	1909.	Per cent. of increase, 1904-1909.*
GENERAL SUMMARY.		
Establishments	640	— 1
Capital	$256,281,000	30
Cost of materials	$60,307,000	25
Salaries	$10,140,000	34
Wages	$28,609,000	14
Miscellaneous expenses	$18,885,000	24
Value of products	$146,329,000	31
Value added by manufacture	$86,022,000	35
Salaried officials and clerks	9,213	28
Average wage earners	50,551	7
Primary horsepower	100,601	12
NUMBER OF PRINCIPAL IMPLEMENTS MADE:	Number. 1909.	Per cent. of increase, 1904-1909.*
Aggregate	5,024,637	29
Seeders and planters, total	533,972	— 1
Seeders	61,970	85
Corn planters	219,245	24
Cotton planters	79,271	—38
Potato planters	23,092	—35
Drills	142,547	35
Seed sowers	7,847	—87
Implements of cultivation	3,287,649	42
Cultivators	905,957	63
Cotton Scrapers	20,180	—10
Harrows	700,820	55
Listers	44,840	95
Plows	1,615,852	28
Disk	22,132	—43
Shovel	254,737	109
Walking	1,110,006	16
Gang, steam, sulky, or wheel	228,977	63
Harvesting implements	1,059,482	11
Grain cradles	22,635	—25
Harvesters	152,351	27
Hayrakes, horse	266,260	13
Mowers	359,264	31
Reapers	58,294	— 4
Other	200,678	—13
Seed separators	143,534	63
Corn shellers	83,272	56
Fanning mills	33,805	47
Thrashers	24,408	140
Horse	822	—63
Steam	23,586	197
Other	2,049	22

*Negative sign denotes decrease.

An International Clay Products Exposition will be held at the Coliseum, Chicago, Ill., March 7-12, 1912.

An Explosion of Acetylene Gas at a farmhouse near Mattoon, Ill., Nov. 30, according to press reports, killed two persons. Presumably, the farmhouse was equipped with an acetylene lighting system.

An Average Speed of 74.45 Miles was maintained for a distance of 111 miles by a Fiat automobile in the recent race for the gold cup of the Automobile Club of America. The driver of the winning car, which was of Italian manufacture, was Mr. David L. Bruce-Brown.

A Defective Rail Caused the Derailment of a passenger train on the Missouri Pacific Ry., Nov. 30, between Joplin, Mo., and Topeka, Kan. Seven persons were injured. Reports state that the train was running at about 16 miles per hour.

A Boiler Explosion in the basement of the Lower Merion Young Men's Christian Association Building at Ardmore, Pa., Nov. 29, wrecked the library room and a barber shop on the ground floor. Reports state that two boilers exploded. The loss is estimated at $5,000.

The Boiler of a Tow-Boat Exploded Dec. 3, in the Ohio River just below Davis Island Dam, near Pittsburgh, Pa. The accident occurred when the boat was in midstream, with all the crew except four men asleep. Five men, including the engineer, two firemen and the captain of the boat, were killed. Reports state that the boilers were last inspected in June, 1911, and were found to be in good condition at that time.

A Minaret Fell From the Tower of the Trinity Building, 111 Broadway, New York City, Nov. 30. The minaret was of stone, weighing about 200 lbs., and the distance it fell is estimated at 275 ft. When striking the pavement the stone was smashed into a large number of pieces, which were thrown in every direction, injuring one or two persons. The accident is ascribed to the action of a large flag which had been raised in celebration of Thanksgiving Day. The flag, it is stated, was wound about the minaret by the wind so as to tear it from its pedestal.

Rapid Engine Building is reported by the Mesta Machine Co., of Pittsburgh, Pa., which recently completed a 32 — 48-in. Corliss engine in the record-breaking time of 16 days. The engine was built for the American Sheet & Tin Plate Co.'s plant at Martin's Ferry, Ohio, to replace an old one that had broken down beyond repair. The order was placed on Oct. 16, 1911, and the complete engine was shipped within 16 days and was put into operation at Martin's Ferry 11 days later.

No part of the engine was in stock, we are informed, so that all parts had to be made from the raw material. Not many years ago the making of the forgings or of the cylinder casting alone for an engine of this size would have required as much as 16 days. The rapidity with which the work was done is credited, by the Mesta Machine Co., to the use of steam-hydraulic forging presses and modern foundry equipment.

A New Water-Supply for Ottawa has been reported by a special commission consisting of Messrs. Allen Hazen, M. Am. Soc. C. E., New York City; Dr. Chas. Hodgetts, of the Dominion Conservation Commission; Mr. Charles H. Keefer, M. Am. Soc. C. E., of Ottawa, and John W. M. McCullough, Provincial Health Officer, Ottawa. The three members of the commission other than Mr. Keefer advised a gravity supply from the Blanche River through McGregor Lake, which we understand is in strict accordance with the report on the new water-supply for Ottawa submitted by Mr. Hazen, Oct. 5, 1910 (see Eng. News, Nov. 10, 1910, page 521). Mr. Keefer submitted a minority report, in which he strongly favored a filtered supply from the Ottawa River, urging this source as being unlimited in quantity, near the city and apparently as fitting in with projected Georgian Bay Canal developments and proposed dam construction at the Little Chaudiere.

The majority of the commission state that the Ottawa River, the present source of supply, is so polluted as to be unfit for use without filtration at either the present intake or any other practical point of intake. They state that the hypochlorite treatment now in use greatly improves the supply through its disinfecting action, but removes neither color nor other organic impurities. As to the possibilities of treating the water by slow sand filtration, alone or assisted, and by mechanical filtration, the majority of the commission states:

> No system of sand filtration, either simple or multiple, without chemical treatment, is capable of removing the color and the excessive amount of organic matter in the Ottawa River water.
>
> Such processes for filtration are successfully applied to many river waters, such as the Thames at London, the Elbe at Hamburg, the Hudson at Albany, and the Delaware at Philadelphia. None of these waters are as highly colored as the Ottawa River water, or carry as large amounts of dissolved organic matter. It should be clearly understood that these processes, although well adapted to conditions in other localities, are not, in our judgment, applicable to the Ottawa River water.
>
> The color and excessive dissolved organic matter in the Ottawa River water may be removed by suitable chemical treatment, followed by filtration. The water so obtained will be in general of good quality. This process is widely and successfully used in British and American cities.
>
> Water so treated will dissolve iron from the pipes and the iron will afterward separate and give rise to complaints. This is known as the red water trouble. It is a serious and objectionable condition, difficult to overcome when soft waters charged with dissolved organic matter are cleaned by chemical treatment.

Present information indicates that with full storage of flood flows 50,000,000 Imp. gals. per day can be drawn from the Blanche River. Storage sufficient for two years' supply, if necessary, could easily be effected "by inexpensive dams in narrow rocky outlets." The drainage area of the Blanche River is rough, rocky and scantily populated and it has sufficient elevation to supply the city by gravitation, and that, too, "at a higher pressure" than is now carried. The commission also states that it will not be necessary to filter the Blanche River water, and, moreover, that this supply without filtration "will be of better quality than the Ottawa River water," after filtration.

The Continuation of Lake Ontario as a Source of water-supply for Toronto has been advised by the City Council. The members of the commission are as follows: Messrs. J. G. Sing, Resident Government Engineer, Toronto, Chairman; T. Aird Murray, Toronto; Isham Randolph, M. Am. Soc. C. E., Chicago, and Willis Chipman, M. Am. Soc. C. E., Toronto, Secretary. The commission advises an early enlargement of the new filtration plant just nearing completion, the immediate installation of a 25,000,000-gal. pumping-engine and the repair of an unused 60-in. water intake conduit. These improvements, the commission says, would just about double the present capacity of the water-works system of Toronto, which is now placed at 45,000,000 Imp. gals. per day. The estimated cost of the improvements is as follows: Enlargement of filtration plant, $750,000; pumping engine, boilers and engine-house, $225,000; repairs to 60-in. conduit, $50,000; engineering superintendence, $105,000; total, $1,130,000. The opinion is expressed that the settled sewage from the disposal works now under construction should be disinfected before discharge into the lake. It is stated that the report is preliminary to a more detailed one which is to follow.

An American Exhibition Aviator, "Ted" Schriver, was killed Dec. 2 at Ponce, Porto Rico, by a drop of 200 ft. Apparently, control of the machine, a Baldwin biplane flyer, was lost on a turn.

A German aviator, named Reeb, was killed on Dec. 3 by a fall during a flight from Munich to Nuremburg.

The Confession of Guilt by the Dynamiters accused of wrecking the Los Angeles "Times" building and the Llewellyn Iron Works at Los Angeles was announced in the daily press Dec. 2, 1911. These men, James B. McNamara and his brother John J. McNamara, were arrested April 22, 1911, following the confession of an accomplice, "Ortie" McManigal. A brief account of the arrest and the events leading up to it is published in Engineering News for April 27, 1911, p. 523.

John J. McNamara's confession, as given in press reports, admits his connection with the dynamiting of the Llewellyn Iron Works on Dec. 25, 1910, corroborating the earlier confession of McManigal, who testified that he was paid by McNamara for doing this "job." James B. McNamara has confessed to placing the charge of explosive which destroyed the Los Angeles "Times" building on Oct. 1, 1911, killing 21 men at work in the building.

On Dec. 5, James B. McNamara was sentenced to life imprisonment, for murder in the first degree, and John J. McNamara was sentenced to imprisonment for 15 years. The court held that each deserved the utmost punishment permissible by law, but the sentences were mitigated in view of the confessions which had been made.

More significance is attached to these confessions from the fact that John J. McNamara, at the time of his arrest, was Secretary and Treasurer of the National Association of Bridge and Structural Iron Workers. Discussion of the probability that these same men were responsible for many other dynamitings was published in Engineering News, April 27, 1911, p. 513. A list compiled by the daily press gives 113 cases of attempted and effective dynamitings during the past six years. In 1910, there were 23 cases, and in 1911 ten more. Only one of those in 1911 (the wrecking of a Westchester & Boston Ry. viaduct at Mount Vernon, N. Y., Sept. 3) occurred after the arrest of the McNamaras.

The connection with the case of detective W. J. Burns, to whom was given much of the credit for the arrests, began in September, 1910, after the dynamiting of two carloads of steel girders belonging to the McClintic-Marshall Construction Co., in East Orange, Ill.

The Longest Tunnel in the World is proposed for construction through the Caucasus Mountains, near Vladikaukaz, Russia, according to "The Engineer" of London. It will be 13 miles long and is to be completed in seven or eight years at an estimated cost of 100 million rubles. A double railway track is to be laid through it. The mountain rivers in the neighborhood will furnish 13,500 HP., which is to be converted into electric energy. A meeting of engineers connected with the Simplon and other well-known European tunnels was recently held to discuss the projected construction.

The Proposal for the State Control of Dams in Pennsylvania, noted on page 639 of our issue of Nov. 23 as having been unanimously approved at a meeting of the Engineers' Club of Philadelphia, was premature. We have since learned on good authority that this subject was reported on by a committee consisting of Messrs. Edwin F. Smith, J. W. Ledoux and John C. Trautwine, Jr. Messrs. Smith and Ledoux recommended the state licensing of engineers entrusted with the design and construction of dams. Mr. Trautwine submitted a minority report in which he urged the formation of a state department of public works to be composed of bureaus so organized that their combined functions should cover not only dams but all other engineering contingencies likely to arise in the near future. To avoid interference with the stated paper of the evening, it was decided to hold a special meeting on the evening of Dec. 9, to consider the majority and minority reports. Meanwhile, printed copies of both reports will be sent out with the notices calling the meeting.

A Salt Water Fire-Protection System for Seattle has been tentatively proposed, since the water-supply of the city was cut off, on Nov. 19, by floods in the Cedar River, the source of the regular supply. A general proposition to this effect has been made before.

Personals.

Mr. George W. Norris, formerly of the banking firm of Edward B. Smith & Co., of Philadelphia, Pa., has been appointed by Mayor Blankenburg Director of Docks and Ferries of Philadelphia.

Mr. Joseph O'Neil, Assoc. M. Am. Soc. C. E., City Engineer of Leavenworth, Kan., since April, 1909, has tendered his resignation to take effect Jan. 1, 1912. His successor has not yet been named.

Mr. John Pullar, formerly Division Foreman of the Atchison, Topeka & Santa Fe Ry., Coast Lines, at Los Angeles, Cal., has been promoted to Master Mechanic of the San Joaquin Valley lines of the same railway at Fresno, Cal.

Mr. Sidney G. Koon, M. Am. Soc. M. E., for several years Editor of the "International Marine Engineering" and recently a metallurgist with the Jones & Laughlin Steel Co., of Pittsburgh, Pa., has joined the staff of Mr. Walter B. Snow, M. Am. Soc. M. E., Publicity Engineer, of Boston, Mass.

Mr. Frederick F. Kett, for several years in charge of the stamp mill at the Melones Mine in Calaveras Co., Cal., and recently mill superintendent of the Braden Copper Co., of Chile, has